M.Arch.(Environmental Design)
Design Thesis – 2011-12

HYDERABAD METRO RAIL

REDUCING THE NEGATIVE IMPACT ON CITY ENVIRONMENT

J.V.UMAMAHESWARA RAO
Hall ticket No.09012NB029

REPORT

School of Planning & Architecture
Jawaharlal Nehru Architecture and Fine Arts University
Mahaveer Marg, Masab tank, Hyderabad-028

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SCHOOL OF PLANNING AND ARCHITECTURE
JAWAHARLAL NEHRU ARCHITECTURE AND FINE ARTS UNIVERSITY

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DEPARTMENT OF ARCHITECTURE

I certify that the Design Thesis entitled **HYDERABAD METRO RAIL:** REDUCING THE NEGATIVE IMPACT ON CITY ENVIRONMENT submitted by Mr. **J.V.UMAMAHESWARA RAO** bearing H.T.No. **09012NB029**, on this ___ day of February 2012 in partial fulfillment of the requirements for the award of the Degree of **MASTER OF ARCHITECTURE (ENVIRONMENTAL DESIGN)** of this University is a bonafide work to the best of our knowledge and may be placed before the Examination Board for their consideration.

Thesis Supervisor | **Thesis Coordinator**

Head, Department of Architecture | **External Examiner**

PRINCIPAL

Design Thesis 2011-12

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Acknowledgement

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I would like to thank my thesis guide Ms.Vijaya Lakshmi Kanti for her guidance at every stage of my work.

Especially my thanks to my parents and my wife, whose love and support enabled me to complete this thesis.

J.V.Umamaheswara Rao

CONTENTS

1 INTRODUCTION

1.1. Synopsis

1.1.1. Aim

The Aim of the Thesis is to give better design and solutions to reduce the negative impact of Hyderabad Metro rail project on the city environment and Traffic.

1.1.2. Research Statements

1. Underground Metro rail Vs Elevated Metro rail?
2. Will the metro project reduces the carbon footprint of the city?
3. Will Metro rail solve the Hyderabad's traffic problems?
4. Will the elevated metro create safety and solve civic issues?

1.1.3. Objectives

The objectives of the Hyderabad Metro rail study are as follows:

- The need of Metro rail project to solve the traffic issues in Hyderabad.
- Impact on the city environment and scope of EIA (Environmental Impact Assessment)
- Problems along the Metro rail corridors.
- Problems to pedestrians.
- Sound pollution, Air pollution, Soil pollution and Water pollution.
- Land acquisition and rehabilitation of people and neighborhoods.
- Impact on heritage buildings and important places and Landmarks.
- Impact on the beauty of the city scape.
- Impact on the land use patterns.
- Possibilities of using existing infrastructure.
- Exploring alternative designs and solutions.

1.1.4. Scope & Limitations

- The scope of study to understand the role of Metro rail project.
- And also the issues in the planning, construction and implementation.
- Its impact on the traffic and environment.
- Its influence on the people, business, land use and other factors along the route.
- Its impact on the urban infrastructure.
- The study is limited to one route of the Hyderabad Metro rail project out of three proposed routes.
- Prototype metro station design to understand the impact on surroundings.

1.1.5. Methodology

1. **Data Collection & Desk Study:**
   - Study on Metro rail projects.
   - Study of an operating Metro rail project in other cities.
   - Study of proposed Hyderabad Metro rail project routes.
   - Study on Traffic and transportation of Hyderabad.
   - Standards for Environmental Quality.
   - Infrastructure and Services.
   - Climatic Aspects for the selected region.
   - Relevant Govt. Policies.
   - Study on existing Road Transportation and MMTS of Hyderabad.
   - Integration of Metro rail with other transportation modes.

2. **Case Study:** Study of an operating Metro rail project in other city.
3. **Defining the Study Area.**
4. **Site visit of Study Area**
5. **Prototype metro station design**
6. **Analysis and interpretation**
7. **Impact on Environment.**
   - Impact on Traffic.
   - Influence on Land use Pattern.

1.1.6. Design solutions and Policies

1.1.7. Inferences

- To propose Design solutions and Policies for reducing the negative impact of Metro rail project on city Environment and Traffic.
- Designing a prototype metro station.

1.2. Background

Hyderabad is a mega city that covers **625 sq. km. of municipal corporation area and 6852 sq. km. of metropolitan area.** It is fast emerging as the **hub of IT, Biotech, Pharma and Tourism sector.** Its strategic geographical location, multilingual and cosmopolitan culture, tremendous growth potential and investment-friendly economic policy are all making it an attractive destination for corporates, entrepreneurs, academicians and homemakers alike. The increasing pressure of the burgeoning population is putting Hyderabad's Transportation System under constant pressure.

The need of the hour is a robust system that is dependable, comfortable, affordable and sustainable. Its population stands at 8 million and is projected to touch 13.64 million by 2021. Currently, over 2.8 million personalized vehicles ply on Hyderabad roads, with an addition of 0.20 million vehicles every year. 8 million motorized trips are made every day, of which, only about 3.36 million or 42% are made by the Public Transportation System (PTS) i.e., buses and local trains. That means the rest of the trips are made by personal vehicles leading to traffic bottlenecks, high pollution levels and a steep increase in fuel consumption.

Above pictures show Charminar (left), the heritage monument of Hyderabad and Cyber Towers (Right), the new image of modern Hyderabad called Hitec City.


1.3. Urban Transport

Urban area administrators today are facing a serious dilemma. They face a choking city and conflicting offers of impossible solutions. In brief they face:

1. Responsibility to solve current chaotic transport problem:

- Roads congested with excessive number of road vehicles
- Low speeds causing pollution and loss of millions of productive man-hours

2. Inability to increase road space

3. Lack of funds

1.3.1. Transportation system:

1. **People:** Comfortable. Safe travel at reasonably high speed at affordable prices for the city dwellers
2. **Cargo:** City needs cargo supplies- an environment friendly system to eliminate trucks from roads
3. **Services:** Municipal house keeping functions to be handled hygienically and efficiently

1.3.2. Transportation for People

1. Easy access within one km to be reduced to 500m on the existing roads.
2. Almost no waiting time(less than 1min) – air condition travel with potential 100kmph speeds.
3. Affordable as compared to existing modes.
4. Assurance of safety not only for those who use the system, **but also for road users**.
5. Minimum noise pollution and emissions.
6. Scalability for next 100 years requirement

1.3.3 Objectivity and clarity

1. Administrators with good intentions should demand that:

- Not a single building, garden, habitat be dislocated by the solution.
- Least or almost no land causing dislocation of previous occupant be required
- Only existing transport zone in the form of roadways be utilized- and the city be not disfigured

2. Solution should not cause further introduction of new road based vehicles on the system, which already is congested.

3. Remedy chosen shall not be worse than the problem.

1.4. Superstructure

The construction of the superstructure of such long distance of viaducts has not only to meet the functional requirement but also to take care of the site constraints such as:

- Allowing free flow of vehicular traffic on the already congested along with chosen alignment,
- Paucity availability of land,
- Existence of charted and uncharted utilities,
- Problems to pedestrians,
- Problems to existing residents, and
- Environmental impact including noise and vibration etc.

1.5. Mitigation Measures:

To have minimum inconvenience to general public the following mitigation measures are required

- Fully barricading the construction corridor,
- Providing proper signage and lighting arrangement,
- Completing the construction in a minimum time frame and in a time bound manner,
- Good house keeping of the surrounding area, and
- Raising the confidence of the public by adopting safety measures, caring for public attitude

(Source: Breaking the Trend Visioning and Backcasting for Transport in India & Delhi, Halcrow Group Ltd in association with Sharad Saxena and Professor David Banister (Oxford University, Transport Studies Unit, Scoping Report, May 2008)

1.6. Projections for Exponential Carbon Emission Growth

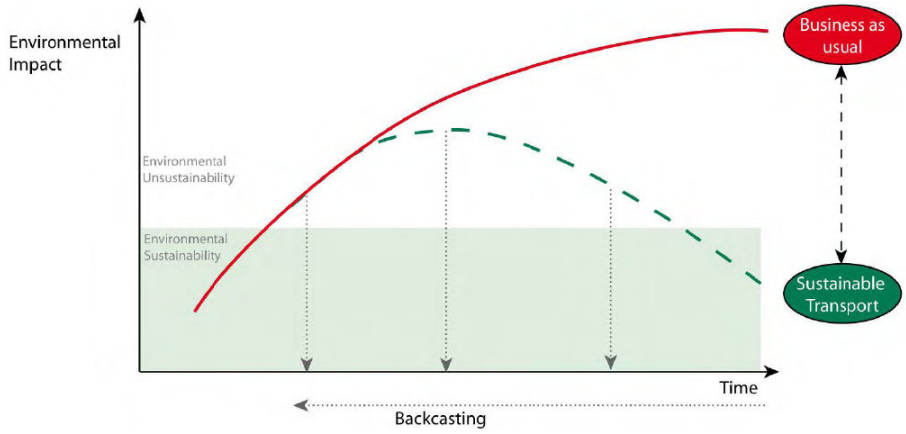
An overwhelming body of scientific evidence now clearly indicates that climate change is a serious and urgent issue. The Earth's climate is rapidly changing, mainly as a result of increases in greenhouse gases (GHG)1 caused by human activities. Climate change is now perceived as a serious global threat and it demands an urgent and far-reaching response. The concentration of atmospheric carbon dioxide (CO2) has increased from a pre industrial value of about 280 ppm to 379 ppm in 2005 (IPCC, 2007), with projections of global concentrations rising to 550ppm by 2050 at current trends, or rising to 550-700ppm by 2050, and 650-1200ppm by 2100, without future intervention. A "sustainable" level of concentrations is seen as around 450ppm.

Emissions from transport are one of the most serious and rapidly growing problems. The transport sector is responsible for almost 25% of global CO2 emissions (IISD, 2004). Transport emissions are growing at approximately 2.1% per year worldwide, and 3.5% per year in developing countries (IEA, 2002). These growth rates make the transport sector the fastest growing source of GHG emissions.

1.6.1. Measurement of Transport Emissions

End Users: include an estimated share of upstream emissions from power stations and refineries allocated back to the sectors using the electricity or fuel (sometimes referred to as 'well to wheel'). For the transport sector this adds around 20% to the total CO2 produced from the tailpipe or source. End user emissions therefore give a more complete picture, however are more difficult (and uncertain) to measure than source user emissions.

Source Users: presented as tailpipe emissions only. Emissions are therefore allocated according to where the fuel (e.g. coal, gas, oil, petrol etc.) is consumed. There is no allocation of emissions arising from fuel refining or electricity generation to the transport sector; this is allocated to the energy sector.



Backcasting is a technique that is often referred to as the "opposite" to forecasting. It involves identification of a particular future scenario(s) and tracing pathways of progress and implementation back to the present.

1.7. Public Transport Systems

In India, the demand for public transport services continues to increase, mainly due to the burgeoning growth of India's cities both in terms of population and land area. However the poor quality of public transport services coupled with rising incomes amongst India's upper and middle classes has ensured that public transport is growing at a far lower rate than private transport. Public transport's modal share is steadily decreasing.

(Source: status of the vehicular pollution control programme in India, CPCB, 2010)

1.7.1. Major vehicle/fuel pollutants

Automotive vehicles emit several pollutants depending upon the type of quality of the fuel consumed by them. The release of pollutants from vehicles also include fugitive emissions of the fuel, the source and level of these emissions depending upon the vehicle type, its maintenance etc. The major pollutants released as vehicle/fuel emissions are, carbon monoxide, nitrogen oxides, photochemical oxidants, air toxics namely benzene, aldehydes, 1-3 butadiene, lead, particulate matter, hydrocarbon, oxides of sulphur and polycyclic aromatic hydrocarbons. While the predominant pollutants in petrol/gasoline driven vehicles are hydrocarbons and carbon monoxide, the predominant pollutants from the diesel based vehicles are Oxides of nitrogen and particulates.

1.8. Health and environmental effects of vehicular pollutants

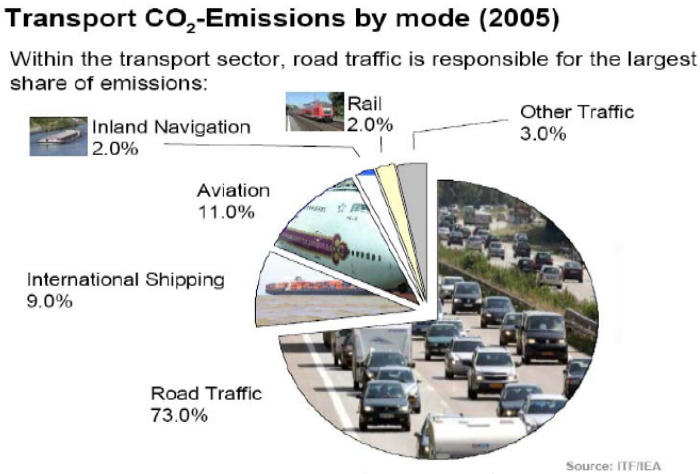
1.8.1. General/Overall Effects:

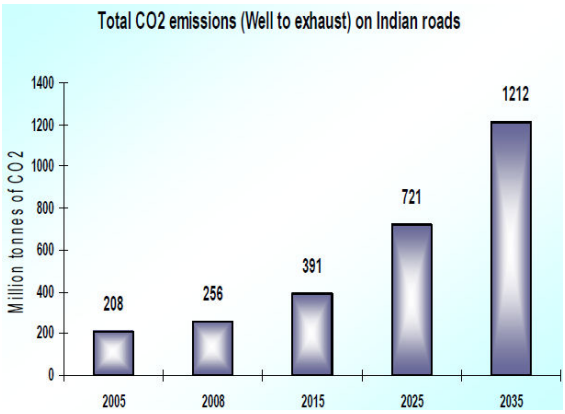
The vehicular emissions have damaging effects on both human health and ecology. There is a wide range of adverse health/environmental effects of the pollutants released from vehicles. The effects may be direct as well as in-direct covering right from reduced visibility to cancers and death in some cases of acute exposure of pollutants specially carbon monoxide. These pollutants are believed to directly affect the respiratory and cardiovascular systems. In particular, high levels of Sulphur dioxide and Suspended Particulate Matter are associated with increased mortality, morbidity and impaired pulmonary function.

1.8.2. Global Warming and Climate Change

The world average temperature has risen by about 1 F° over the past century. It is widely accepted that the global warming is related to anthropogenic Green House Gases (GHGs). GHGs include, the common gases namely , carbon dioxide and water vapor, and rarer gases such as nitrous oxide, methane and chlorofluorocarbons (CFCs) whose properties relate to the transmission or reflection of different types of solar radiations. The increase in such gases in the atmosphere is a result of the burning of fossil fuels, emission of pollutants into the atmosphere by power plants and vehicle engines, etc. Transport sector contributes around 14% towards the global emissions of green house

gases. Carbon dioxide represents the largest proportion of basket of greenhouse gas emissions. During, the past three decades, carbon dioxide emissions from transport have increased faster than those from all other sectors and are projected to increase more rapidly in future. The Road transport alone emits around 16% of the global CO_2 emissions (Source: OICA).

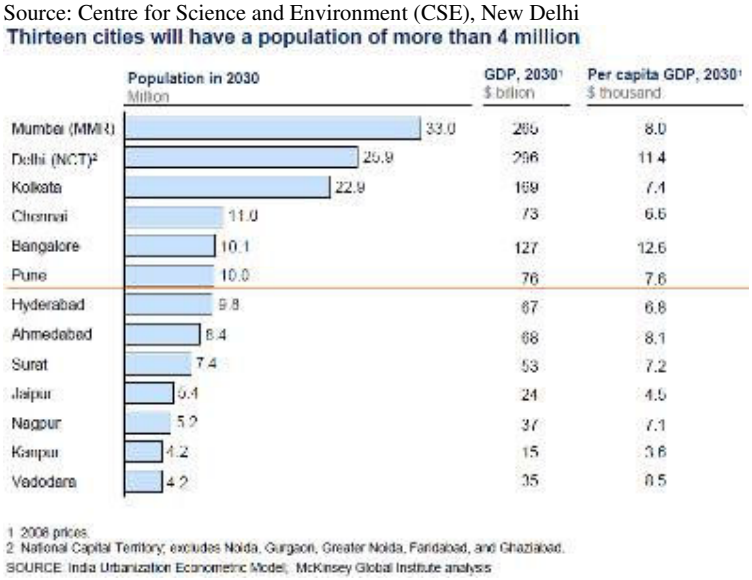




Source: Centre for Science and Environment (CSE), New Delhi

City	Pollution Load in Metric tones per day			
	CO	NOx	HC	PM
Delhi	421.84	110.45	184.37	12.77
Mumbai	189.55	46.37	89.93	10.58
Kolkata	137.50	54.09	47.63	10.80
Chennai	177.00	27.30	95.64	7.29
Bangalore	207.04	29.72	117.37	8.11
Hyderabad	163.95	36.89	90.09	8.00
Kanpur	28.73	7.25	11.70	1.91
Agra	17.93	3.30	10.28	0.91

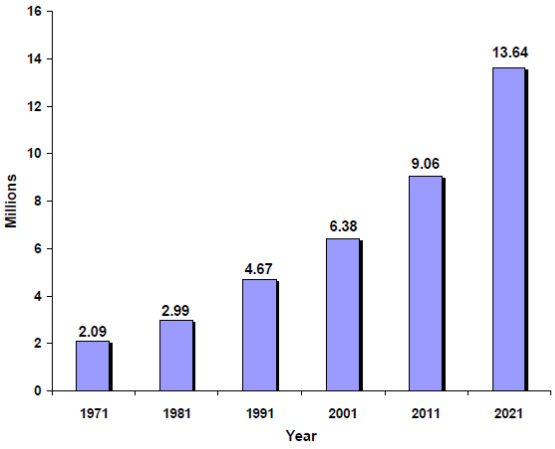
Source: Auto Fuel Policy Report



1.9. Introduction to Hyderabad Transportation

1.9.1. Hyderabad Population

The population of Hyderabad city grew from 0.448 million in the year 1901 to 6.383 millions in the year 2001. The city is defined to be the area under MCH, 10 municipalities and remaining part of HUDA area. Projected population as per Draft Master Plan - 2021 for HUDA area is 9.055 millions and 13.644 millions in the year 2011 and 2021 respectively. Besides there is a floating population of the order of a million a day.



Vehicle population in Hyderabad (Upto Mar.)

Type of Vehicle	2001	2005	2009	2011
Two Wheelers	8,56,397	11,57,564	15,30,712	17,30,079
Motor Cars/Jeeps	1,26,472	1,99,904	3,04,234	3,62,090
Goods Vehicles	40,251	64,747	89,091	95,856
State Carriages/ Mini buses	2,263	12,698	16,970	18,800
Auto Rickshaws	58,851	68,469	68,469	75,163
Taxis	6,355	17,907	31,876	33,935
Tractors	263	741	1,232	1,518
Others	882	5,440	7,316	8,587
Total vehicles	10,91,734	15,27,470	20,49,900	23,26,028

1.9.2. Motor Vehicle Growth

The main forms of transport in the city presently are two-wheelers, cars and Public Transport which comprise mainly of buses and three wheelers. The number of registered motor vehicles was 1.56 million in 2001. The growth in motor vehicles has been at a rate of 11.5% per annum during the period 1996-2001. The share of two wheelers out of the total registered vehicles is over 74%. The city has also a very large number of three wheelers (more than 71,000). This indicates the inadequate supply of public transport system.

The number of vehicles on City Roads is increasing at higher than growth rate of population. The chaotic growth of vehicular population has been creating:

- Alarming levels of pollution
- Acute congestion of roads and consequent heavy time loss
- High accident rates resulting deaths and injured.

1.9.3. Air pollution

High growth in motor vehicles has led to over-crowded roads and a polluted environment. The transportation sector is the main contributor to the ever increasing air pollutant concentration in Hyderabad. According to a recent study, cars and two-wheelers contribute 11% and 78% respectively of the total transport related air pollution and vehicles are responsible for around 64% the total air

pollution load. The alarming increase in the pollution has been primarily responsible for most of the respiratory problems. Higher pollution is largely due to inadequate public transport system.

S.No.	Year	Total Load (Tonnes/Day)
1	1997-1998	934
2	1998-1999	978
3	1999-2000	1040
4	2000-2001	1123
5	2001-2002	1272

Source: APPCB

Ambient Air Quality in City

	RSPM	TSPM	SO_2	NOx	Noise dB		CO mg/m³	
					Normal	Peak	Normal	Peak
Standard	100	200	80	80	65	-	4mg/m³	-
Abids	90	271	5	29	79	89	2	21
Panjagutta	124	374	5	31	82	90	4	16
Paradise	119	337	5	29	80	89	1	12
Charminar	116	321	6	31	80	92	2	19
Zoo Park	45	147	4	17	70	79	1	12
KBR Park	44	135	4	14	70	78	1	9

RSPM/ TSPM/ SO_2/ NOx / in µg/m³

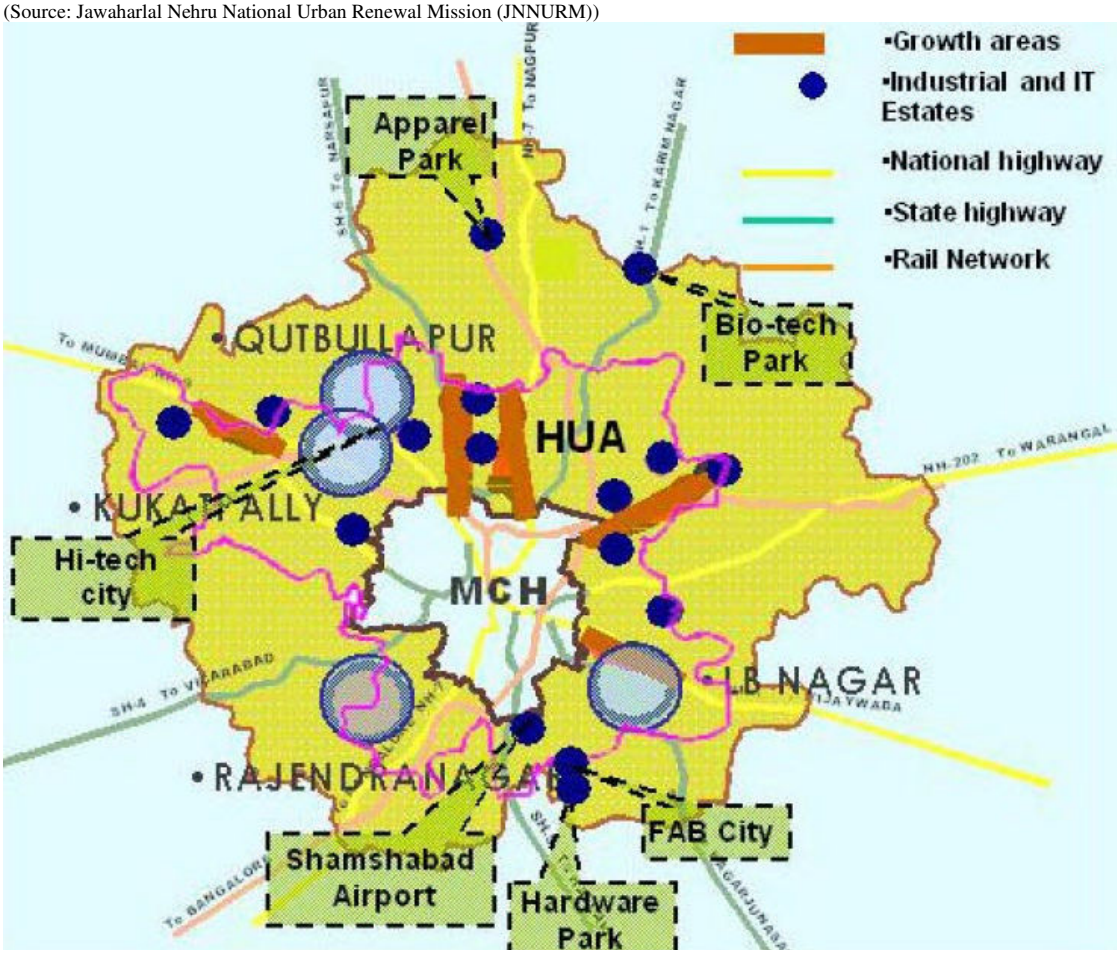
All Values in micrograms per cubic metre.

RSPM - Respirable Suspended Particulate Matter.
TSPM - Total Suspended Particulate Matter.
SO2 - Sulphur Dioxide.
NOx - Oxides of Nitrogen.

CO - Carbon Monoxide - milligrams per cubic metre.

1.9.4. Areas of Economic Activity & Location Aspects of Growth

(Source: Jawaharlal Nehru National Urban Renewal Mission (JNNURM))



Economic growth centers of Hyderabad

The economic activities, particularly manufacturing and associated facilities, are concentrated in Ramachandrapuram, Patancheru, Balanagar, Uppal, Cherlapalli, Jeedimetla, and Moula Ali. The developments, on one hand contributed to the economic growth of the city and on the other responsible for the spatial growth, particularly the growth of the surrounding areas. The economy of Hyderabad is witnessing a transformation from traditional manufacturing towards a knowledgebased economy. Knowledge sector, particularly Information Technology and IT enabled services (ITES) along with the Biotechnology is gaining momentum in the State.

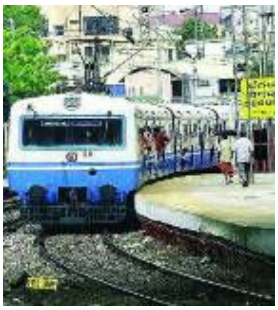
1.10. Public Transport System

Public transport system should be the soul of a city. The presence of a good public transport system can deliver better environmental conditions, faster speeds of travel, better mobility and economic growth. The existing public transport in Hyderabad mainly comprises bus system operated by the State run Andhra Pradesh Road Transport Corporation (APSRTC) and Multi Model Transport System (MMTS) trains.

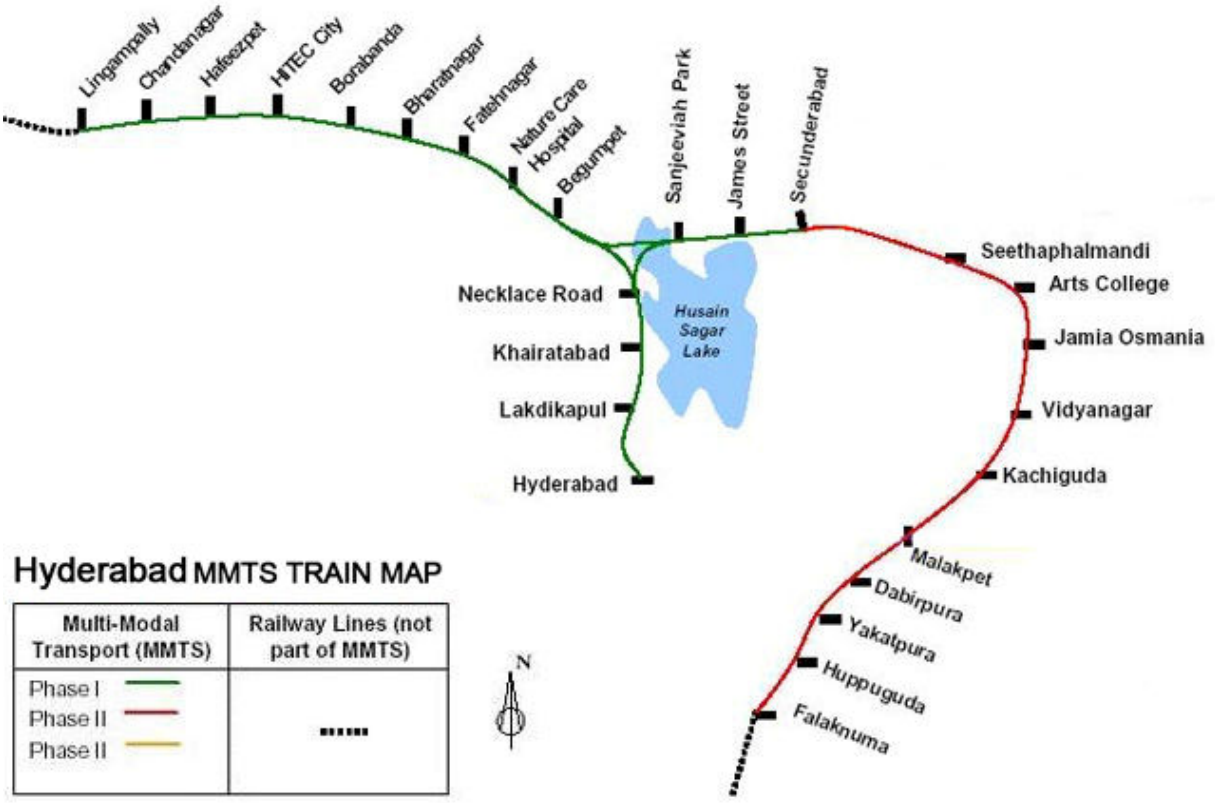
1.10.1. MMTS

(Source: http://mmts.co.in, http://www.mmtshyd.com, http://en.wikipedia.org/wiki/Multi-Modal_Transport_System_%28Hyderabad%29)

MMTS (Multi-Modal Transport System) is Hyderabad's city train service. It was flgged off on August 9, 2003, an associate of The South Central Railway (SCR), is presently running 84 services a day, covering 27 stations and connecting Secunderabad, Falaknuma and Lingampally, over the existing railway network. Around 65,000 to 70,000 commuters use MMTS everyday. There are First Class & General class compartments, and a special Ladies compartment. Now, there is a **combined pass issued by the state-owned APSRTC and MMTS**. So buying a single pass will help in travelling by bus as well as the train. The first phase covers a distance of 43 km and 26 stations in both the Secunderabad-Lingampally and Hyderabad-Lingampally sections. This is an **ideal public transport for people working in and around HiTech City, Madhapur, Kondapur, Manikonda & Gachibowli.**



MMTS stations at Begampet, Lakdikapul and Necklace road.



1.10.2. APSRTC – City buses

(Source: http://apsrtc.gov.in/, http://en.wikipedia.org/wiki/Transport_in_Hyderabad,_India)

Hyderabad has an extensive bus service operated by APSRTC inside the city and to various places across the country. The Mahatma Gandhi bus station or the Imlibun bus station as it is locally known was once the largest bus station in Asia. It is now the third biggest station in Asia. Other major bus stations include Jubliee bus station (JBS), Dilsukhnagar bus station. The APSRTC operates point to point bus services which connect important places within the city, with a very good frequency. The buses are exceptionally clean and services are very user friendly when compared to other cities in India. There are **4000+ buses in the city running** the point to point service.

APSRTC has several kinds of services like:

1.Seetala HamsaMetro 2.Deluxe 3.Metro Express 4.Ordinary

Seetala Hamsa an air-conditioned luxury bus where as Metro Deluxe and Metro express are luxury and semi-luxury services respectively, and have fewer stops allowing a faster commute at a marginally higher price.

Every day view at some location in Hyderabad; RTC bus breaks down on city roads.

1.10.3. Heavy rain brings Hyderabad city to standstill – Water logging - Traffic jams

Traffic jam between Punjagutta – Nims (Left). Old city area (Right)

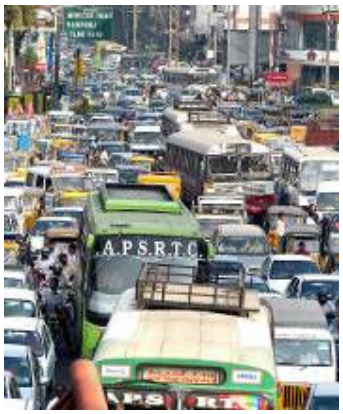
Khairatabad area

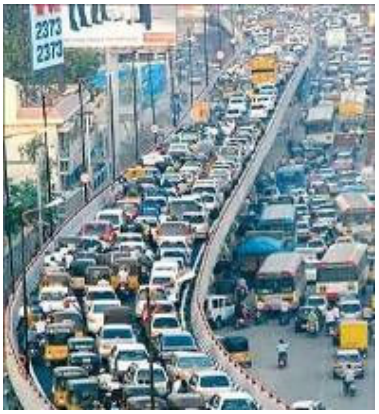
Paradise area

1.10.4. Hyderabad Roads – More vehicles - Traffic jams


Charminar area


Begumpet area (Left). Paradise area (Right)



Traffic Jam on roads at different places in Hyderabad.

1.11. Introduction to Hyderabad Metro Rail project

A people-friendly city is that which provides a good quality of life. An efficient, safe, reliable and comfortable public transportation system is one of the pre-requisites of good living. The answer lies in Mass Rapid Transit System (MRTS) also called Metro rail. Accordingly, the development of Metro Rail was approved for 71.16 km., covering three high density traffic corridors of Hyderabad. The Metro Rail System has proved to be the most efficient in terms of energy consumption, space occupancy and numbers transported.

Hyderabad Metro Rail project covers three high density traffic corridors of Hyderabad:

(1) Miyapur-LB Nagar (28.87 km - 27 stations)
(2) JBS-Falaknuma (14.78 km - 16 stations)
(3) Nagole-Shilparamam (27.51 km - 23 stations)

Total: 71.16 km; 66 stations.

The Phase I of the project includes 3 lines covering a distance of 71.16 km and is expected to be operational by 2014.

(Source: Hyderabad Metro Rail (MRTS) Project - Executive Summary, http://hyderabadmetrorail.in)

2 DESK STUDY

2.1. Rapid Transit System

A rapid transit railway system is an electric passenger railway in an urban area with a high capacity and frequency, and grade separation from other traffic. Rapid transit systems are typically located either in underground tunnels or on elevated rails above street level. Outside urban centers, rapid transit lines may run on grade separated ground level tracks.

Service on rapid transit systems is provided on designated lines between stations using electric multiple units on rail tracks, although some systems use guided rubber tyres, magnetic levitation, or monorail. They are typically integrated with other public transport and often operated by the same public transport authorities. Rapid transit is faster and has a higher capacity than trams or light rail, but is not as fast or as far-reaching as commuter rail. It is unchallenged in its ability to transport large amounts of people quickly over short distances with little land use.

The first rapid transit system was the London Underground, which opened in 1863. The technology quickly spread to other cities in Europe, and then to the United States where a number of elevated systems were built. At first these systems used steam locomotives, with the term later coming to entirely mean electric systems. Since then the largest growth has been in Asia and with driverless systems. More than 160 cities have rapid transit systems, totaling more than 8,000 km (4,900 miles) of track and 7,000 stations. Twenty-five cities have new systems under construction. The biggest metro system in the world by length of routes and number of stations is the New York Subway, however by length of lines the largest are the London Underground and Shanghai Metro. The busiest metro systems in the world by daily and annual ridership are the Tokyo Metro, Moscow Metro and Seoul Metro.



2.2. Metro planning – world facts

All developed countries start planning for a Metro when the population of the city nears one million mark. By the time the population level reaches two million mark a Metro network is in place.

2.2.1. Types of metro

A Metro can be either **underground** or **Elevated** and in case of outskirts of the cities **on the ground** even.

Metros classified as per capacity:

- Heavy capacity – with a capacity of 60-90,000 phpdt.
- Medium capacity – with a capacity of 40-50,000 phpdt, or,
- A light metro with the capacity ranging from 25-30,000 phpdt.

(phpdt: Peak hour peak direction traffic)

When the traffic volume exceeds 12,000 phpdt it can be handled only by a rail-based Metro System. Metros can be either with pneumatic wheels or steel wheels on steel rails. In either case the traction is by electric energy.

2.2.2. Types of project feasibility analysis:

- Technical feasibility
- Marketing feasibility
- Socio-economic feasibility
- Managerial feasibility
- Financial feasibility

India has huge population and as long as people continue to move into cities in large numbers the government may find it difficult to fix the urban infrastructure issues of the metro cities, mainly Traffic and Transportation. Hence significant policy changes are necessary for economic development to spread to all areas of the country to slow down the pace of migration of rural Indians into cities.

"The physical structure of a city, its size and sprawl, its way of life and character, are all dependent up on the nature and quality of urban transport system." - UN ESCAP report, May 1986.

2.3. Metro Rail in World cities

2.3.1. Singapore

(Source: http://en.wikipedia.org/wiki/Mass_Rapid_Transit_%28Singapore%29, http://www.smrt.com.sg/main/index.asp)

The **Mass Rapid Transit** or **MRT** is a rapid transit system that forms the backbone of the railway system in Singapore, spanning the entire city-state. The initial section of the MRT, between Yio Chu Kang Station and Toa Payoh Station, opened in 1987 establishing itself as the second-oldest metro system in Southeast Asia, after Manila's LRT System. The network has since grown rapidly as a result of Singapore's aim of developing a comprehensive rail network as the main backbone of the public transport system in Singapore with an average daily ridership of 1.952 million in 2009, just over 63% of the bus network's 3.085 million in the same period.

The MRT has 79 stations with 129.7 kilometers of lines and operates on standard gauge. The rail lines have been constructed by the Land Transport Authority, a statutory board of the Government of Singapore, which allocates operating concessions to the profit-based corporations SMRT Corporation and SBS Transit. These operators also run bus and taxi services, thus ensuring that there is a full integration of public transport services. The MRT is complemented by the regional Light Rail Transit (LRT) systems that link MRT stations with HDB public housing estates. Services operate from about 5:30 am and usually end before 1 a.m. daily with frequencies of approximately three to eight minutes, and services extended during festive periods.

Locale	Singapore
Transit type	Rapid transit
Number of lines	4
Number of stations	79
Daily ridership	1.952 million (2009)
Began operation	7 November 1987
Operator(s)	SMRT Corporation & SBS Transit
System length	129.7 km (80.59 mi)
Track gauge	1,435 mm (4 ft 8 ½ in) Standard gauge

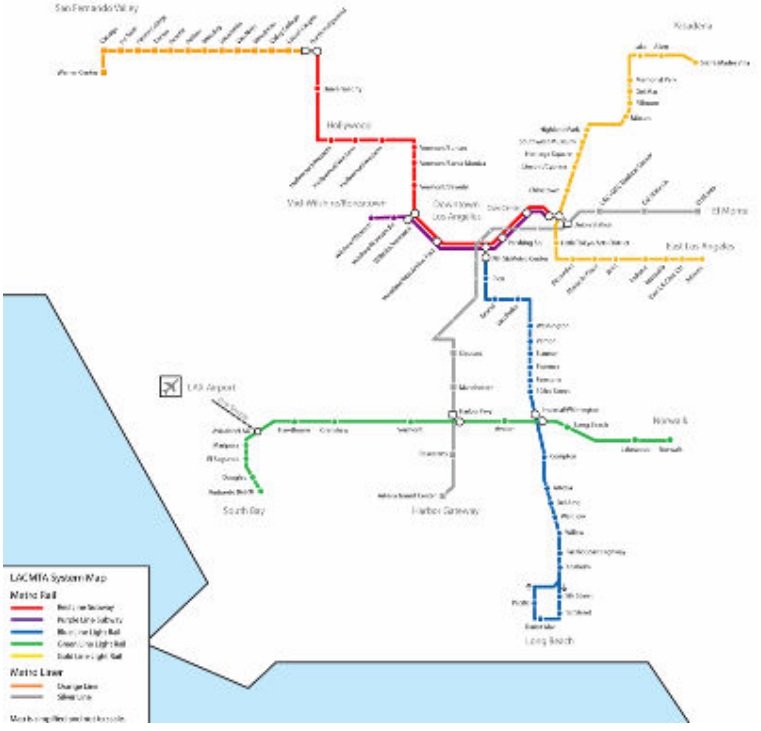
2.3.2. Los Angeles

(Source: http://en.wikipedia.org/wiki/Metro_Rail_%28Los_Angeles_County%29,http://www.metro.net/)

Metro Rail is the rapid transit rail system serving Los Angeles County, California. It is owned and operated by the Los Angeles County Metropolitan Transportation Authority (Metro). Since opening in 1990, the network now comprises five lines, including two heavy rail subway lines and three light rail lines. Altogether, these lines total 79.1 miles (127.3 km) of rail, 70 stations, and over 350,000 daily weekday boarding as of September 2010.

The Metro Rail system is the indirect descendant of the Pacific Electric Red Car and Los Angeles Railway Yellow Car lines, which operated in the area from the early to middle twentieth century.

Locale	Los Angeles County, California
Transit type	Rapid transit (heavy rail and light rail)
Number of lines	5
Number of stations	70 (23 under construction)
Daily ridership	308,678 (September 2010)
Began operation	1990
Operator(s)	Los Angeles County Metropolitan Transportation Authority (LACMTA)
System length	79.1 mi (127.3 km)
Track gauge	4 ft 8 ½ in (1,435 mm) (standard gauge)



2.3.3. London

(Source: http://en.wikipedia.org/wiki/London_Underground, http://www.tfl.gov.uk/modalpages/2625.aspx)

The **London Underground** (also known as **the Tube** or **The Underground**) is a rapid transit system serving a large part of Greater London and some parts of Buckinghamshire, Essex and Hertfordshire in England. It is the oldest underground railway in the world, the first section of which opened in 1863 on what are now the Circle, Hammersmith & City and Metropolitan lines. In 1890 it became the first to operate electric trains. The whole network is commonly referred to by Londoners and in official publicity as **the Tube**, although that term originally applied only to the deep-level bored lines, along which run trains of a smaller and more circular cross-section, to distinguish them from the sub-surface "cut and cover" lines that were built first.

The earlier lines of the present London Underground network were built by various private companies. They became part of an integrated transport system in 1933 when the London Passenger Transport Board (LPTB) or *London Transport* was created. The underground network became a separate entity in 1985, when the UK Government created London Underground Limited (LUL). Since 2003 LUL has been a wholly owned subsidiary of Transport for London (TfL), the statutory corporation responsible for most aspects of the transport system in Greater London, which is run by a board and a commissioner appointed by the Mayor of London.

The Underground serves 270 stations and has 402 kilometers (250 mi) of track, making it the second largest metro system in the world in terms of route miles after the Shanghai Metro. It also has one of the largest numbers of stations. In 2007, more than one billion passenger journeys were recorded, making it the third busiest metro system in Europe after Moscow and Paris. The tube is an international icon for London, with the tube map, considered a design classic, having influenced many other transport maps worldwide. Although also shown on the Tube map, the Docklands Light Railway (DLR) and London Over ground are not part of the LUL network.

Locale	Greater London, Chiltern, Epping Forest, Three Rivers and Watford
Transit type	Rapid transit
Number of lines	11
Number of stations	270 served (260 owned)
Daily ridership	2.93 million, 3.4 million (weekdays) (approximate)
Began operation	10 January 1863
Operator(s)	Transport for London (TfL)
System length	402 kilometers (250 mi)
Track gauge	1,435 mm (4 ft 8 ½ in) Standard gauge

2.4. Metro Rail in Indian cities

(Source: The city and the metro – Report - A National Level Round Table – Pune 2010)

Indian cities, unlike their European counterparts do not have well defined central business districts where large number of working class people are required to be transported in and out, thus makes it difficult to justify a high-capacity system such as a metro rail system. If one considers door-to-door trips then metro does not save time for typical travel distances, since the time to access a metro station and delays within the metro station also need to be considered. Thus car travel, and hence congestion would not be resolved by metro, a myth that people needed to understand. In addition, he felt that every interchange imposes a significant penalty on the commuter, thus making the whole idea of feeder routes a non-starter.

"By enabling longer distance travel and suburban lifestyles, metro systems may promote urban sprawl and increase the carbon footprint of the city."

- Prof. Dinesh Mohan from the Transportation Research and Injury Prevention Programme of IIT Delhi.

2.4.1. Bangalore

The metro rail plan for Bangalore, proposed in 2005 by DMRC, was expeditiously approved and currently the city is building two metro lines of about 40-odd km length. **Environmental Impact Assessment (EIA) was not statutorily required of the metro proposal, though metro rail systems have a significant impact on the environment during construction and also potentially impact parks, open spaces, trees, underground aquifers, and result in displacement of people and affecting living and built-up heritage.**

2.4.2. Kochi

Kochi city currently has a population of under 6 lakhs and even the urban agglomeration including many villages around Kochi only has a population of about 11 lakhs. Moreover, Kochi is also the first city in India to have a birth rate that is below the replacement level and therefore its population is not expected to grow fast either, and the **city's population is only expected to reach about 6.5 lakhs (and 14 lakhs for the agglomeration) in 2026! Therefore, it was surprising that the city proposed a metro rail as a solution to its transport problems.**

It is estimated that the modernization and improvement of the ferry systems – currently being neglected – present in 12 of the 16 urban local bodies (ULBs) would take only about Rs. 100 crores. Similarly, he said there had been a proposal to improve the surface train system, which would also have costed in the region of Rs. 100 crores. In contrast, the proposed metro system would cost Rs. 5000 crores. Moreover, the proposed metro rail route runs parallel to existing railway lines on which suburban trains can be easily run. **The Central Government guidelines state that metro systems are intended for cities with populations of at least 3 million (30 lakhs). Therefore, a metro rail proposal for Kochi (and cities such as Ludhiana, Chandigarh and perhaps Jaipur) clearly goes against the guidelines of the Central Government.**

2.4.3. Mumbai

Mumbai, like Bangalore, already has a metro rail under construction. The current discourse tends to focus more on issues such as over-riding of ULBs, controversies regarding land acquisition, worries about cost escalation, and slippages of schedule. The total cost escalation of the project which is now already pegged at Rs. 50,000 crores for the 150 km project. The harm to the urban fabric being caused by the construction being undertaken for the metro (and the skywalks), as it not only leads to visual pollution but also poses severe risks in terms of fire hazards and so on. He said the Mumbai fire department has said that it will not be able to service many buildings that lie very close to the metro line.

2.4.4. Delhi

The original metro proposal stated that about 3 million people would be carried daily by the system in Phase 1 and this was later scaled down to about 2.2 million. However, in reality, the system carries less than a million people today though phase 1 has been completed. **The property values along the corridor have increased** (in some cases by up to 4 times), resulting in increased Government revenue from properties, he wondered **whether the Delhi metro project was a transport project or a property development project.** About 120 competing bus routes were cancelled and bus fares increased by about 130% in the same period that metro fares increased by only about 70%. Further, he said the **metro system was not accessible to the poor as its fares were not affordable to them.** On displacement and livelihoods, the Delhi High Court ordered the eviction of about 200,000 families for the metro, only about 50,000 had been resettled. Moreover, even these **families have been displaced from their original locations to far away places from where access to jobs becomes harder.**

2.4.5. Pune

Pune Municipal Corporation to get inputs from citizens by explaining the metro rail project to them, and lack of satisfactory replies to the many concerns raised by citizens' groups.

Lack of sufficient justification for the chosen alignment, insufficient integration with other modes of transport etc. Potential impact of the over-ground metro on the urban fabric of the city, and resultant visual and noise pollution.

2.5. Common concerns

Based on the experiences of the cities, it was clear that there were common themes and concerns about the way metro rail systems were being pursued across the country. These are as follows.

1. Metro rail systems are being justified in cities based on crude parameters such as **city population**, rather than a comprehensive vision and studies based on **traffic demand projections**.

2. Metro systems have consistently **under-achieved in terms of projected ridership** and overshot their cost estimates.
3. There is also a common tendency to treat **metro rail systems as stand alone projects** rather than an integrated part of a larger urban transport system. Thus, there is often little or **no attempt at integrating** such systems with other modes of transport.
4. There is also a consistent pattern of **ignoring, delaying or shelving other, more cost effective transportation** options (such as existing bus systems or rail networks) to promote metro systems.
5. Transparent and **participative decision making has generally been lacking** across cities where metro systems are concerned.
6. The social, environmental and cultural impact assessment of these systems appears to be inadequate due to **exemptions from statutory EIA processes**.
7. Across cities, it is found that there has been **hurried planning of metro systems leading to *ad hoc* changes** (in alignment, grade etc.) during implementation.
8. It appears that there are **no well-defined criteria to decide between elevated and underground corridors**.

A city must have a development plan and a comprehensive mobility vision and plan, based on systematic and comprehensive studies. A metro rail project (or any large transport project) should be undertaken only if it is compatible with this vision and plan.

The final set of objectives should be arrived at through a process of public consultation.

a. Minimize the need for mobility through development and zoning mechanisms.

b. Focus on mobility of people rather than vehicles.

c. Promote non-motorized modes of transport such as walking and cycling.

d. Provide access to safe, affordable and reliable transport services for all classes of people from origin to destination.

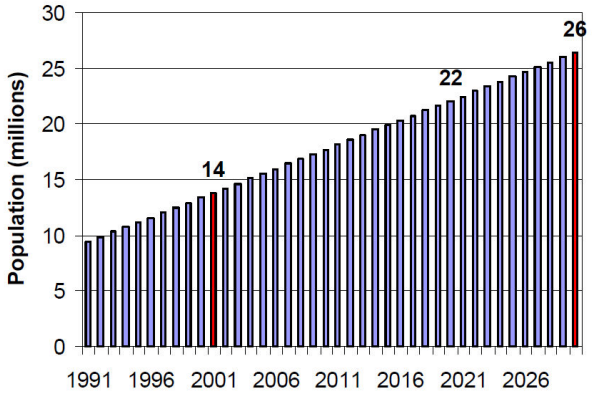
e. Encourage optimally dense, mixed land-use development.

Since metro systems are very expensive to build and operate and take a long time to implement, all other alternatives must be explored and exploited to the fullest extent before deciding whether a city needs a metro rail.

3 CASE STUDY
DELHI METRO RAIL

3.1. Delhi

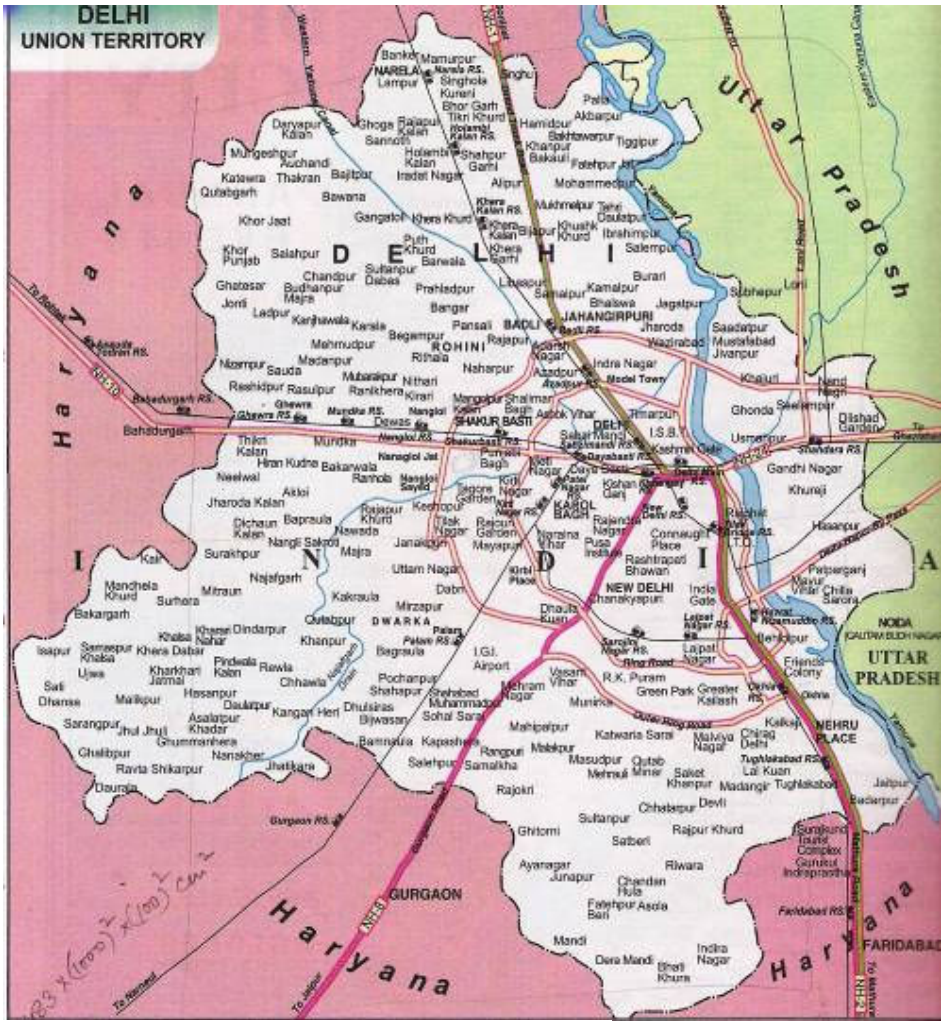
New Delhi is the Capital city of India. Delhi as a mega metropolis and as the Capital of India has a distinct and unique character. Delhi is a historical city whose remnants are spread right from Mehrauli to Shahjahanabad. Large number of monuments are scattered all over Delhi. The built heritage of Delhi is an irreplaceable and nonrenewable cultural resource. Delhi is situated in the northern part of the country and lies between latitudes 28° 24' 17" and 28° 53' 00" North and longitudes of 76° 50' 24" and 77° 20' 37" East. It shares its boundary with theStates of Uttar Pradesh and Haryana. Delhi has a geographical area of 1,483 sq. km. and population of 13,850,507 as per 2001 census records. Its maximum length is 51.90 km. and greatest width is 48.48 km. Delhi has a population density of about 9340 persons per sq. km.



(Left) Red Fort at Delhi near Chandni Chowk Metro station. (Right) Population growth of Delhi (Source: Breaking the Trend Visioning and Backcasting for Transport in India & Delhi, Scoping Report, May 2008)

3.1.1. Population of Delhi

The city of Delhi has grown rapidly in area, density and population. Its spatial area has expanded fifteen fold since 1911. In 1991, 29 new towns were annexed, increasing the area from 445 to 1,483 sqkms. The population of Delhi has increased from 1.7 million in 1951 to over 13 million in the year 2000. The present National Capital Region (NCR) comprises of a total area of 33,578 sqm. including areas of Delhi (1483 sq. kms), Haryana (13413 sq. kms.), Uttar Pradesh (10853 sq. kms.) and Rajasthan (7829 sq. kms).Population projections are that Delhi will reach 22 million by 2020 (Bose and Sperling, 2001). Extrapolating the existing trends mean that the population will exceed 26 million people by 2030.



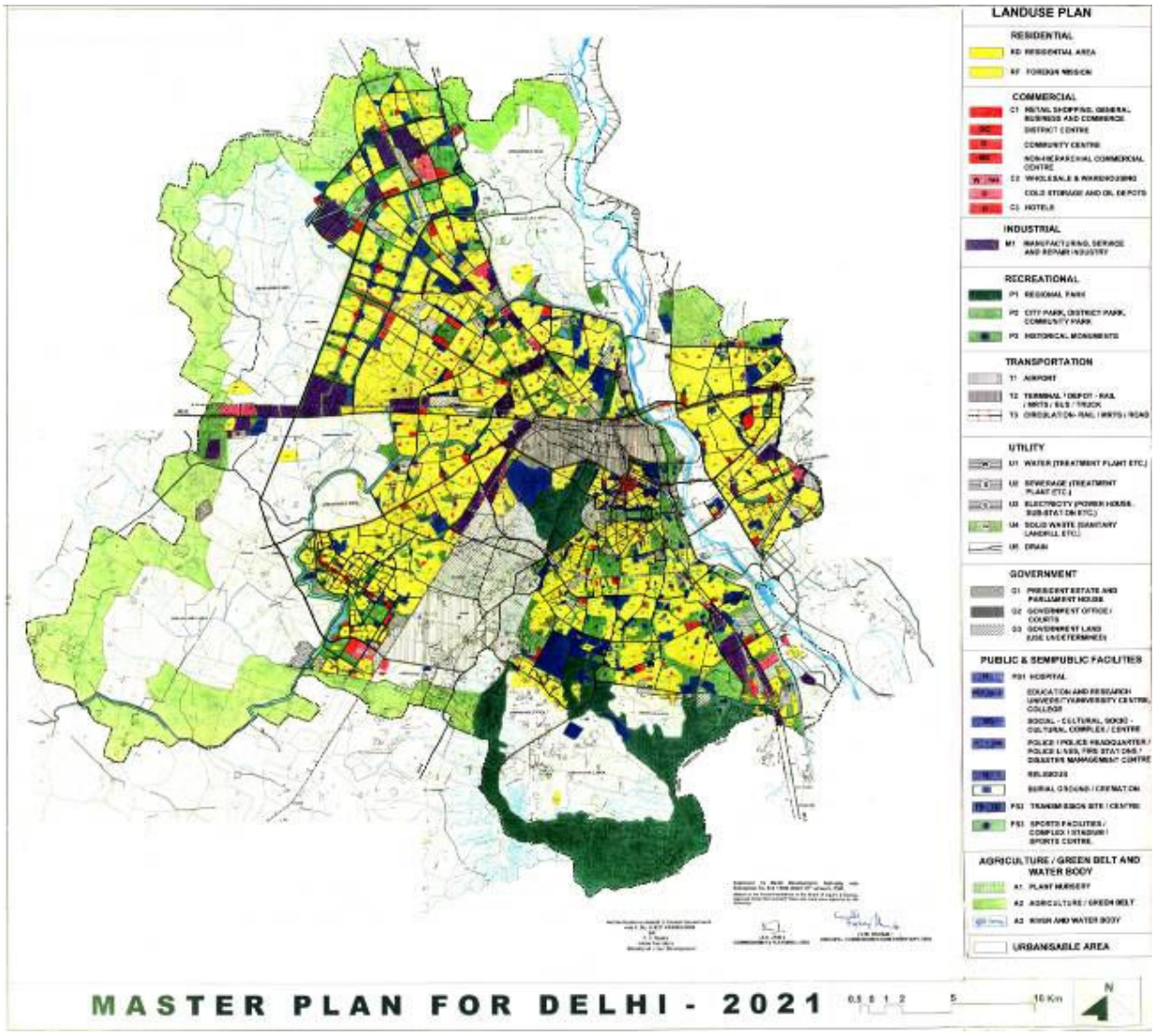
Five Yearly Estimates of Projected Population

Year	Population (In lakh)
2001	137.8
2006	162.0
2011	182.0
2016	199.0
2021	230.0

Source: Census of India and projection by MPD - 2021

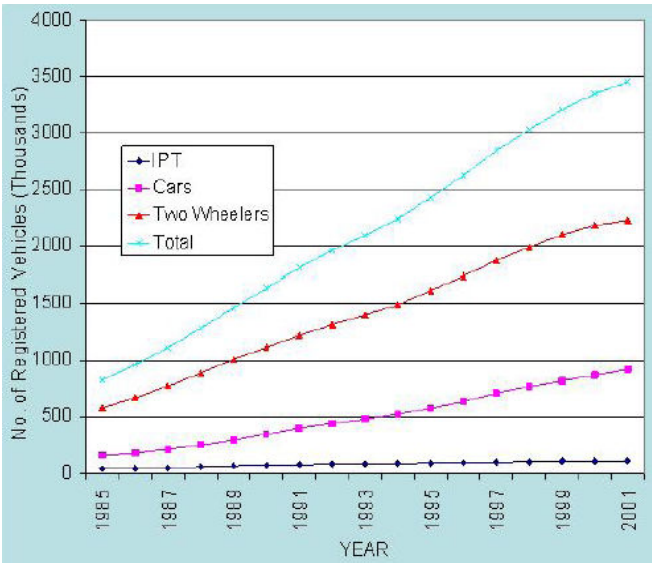
Year	Addition by Natural Growth	Increase by Migration	Net Increase (in lakhs)
1981	12.0 (55.8%)	9.5 (44.2%)	21.5 (100%)
1991	18.9 (59.2%)	13.0 (40.8%)	32.0 (100%)
2001	27.6 (63.3%)	16.0 (36.7%)	43.6 (100%)
2011	24.2 (54.8%)	20.0 (45.2%)	44.2 (100%)
2021	24.0 (50%)	24.0 (50%)	48.0 (100%)

Source: Census of India and projection by MPD- 2021



LAND USE	% OF LAND
Residential	45-55
Commercial	3-4
Industrial	4-5
Green/ Recreational*	15-20
Public & Semi-Public Facilities	8-10
Circulation	10-12

* This does not include green areas under various specific gross land use categories



3.1.2. Vehicles growth in Delhi

The period between 1981 and 2001 has seen a phenomenal increase in the growth of vehicles and traffic in Delhi. There has been a rise in per capita trip rate (excluding Walk Trips) from 0.72 in 1981 to 0.87 in 2001. Keeping in view the population growth, this translates into an increase from 45 lakh trips to around 118 lakh trips. The population of vehicles (four wheelers, three wheelers and two wheelers) has increased from 5.13 lakhs in 1981 to 32.38 lakhs in 2001, and the number of buses has grown from 8,600 to 41,483 during this period. The ratio of the registered vehicles to urban road length, which was 88 vehicles per km. in the year 1990, had increased to 131 vehicles per km. in 1999, even as the road length increased from 26500 kms. by 4400 kms.

The result is extreme congestion on Delhi roads, ever slowing speeds, increase in road accidents (5 persons killed and 13 injured everyday), fuel wastage and environmental pollution with motorized vehicles alone contributing to about two thirds of the atmospheric pollution. As cities grow in size, the number of vehicular trips on road system goes up. This necessitates a pragmatic policy shift to discourage private modes and encourage public transport once the level of traffic along any travel corridor in one direction exceeds 20,000 persons per hour.

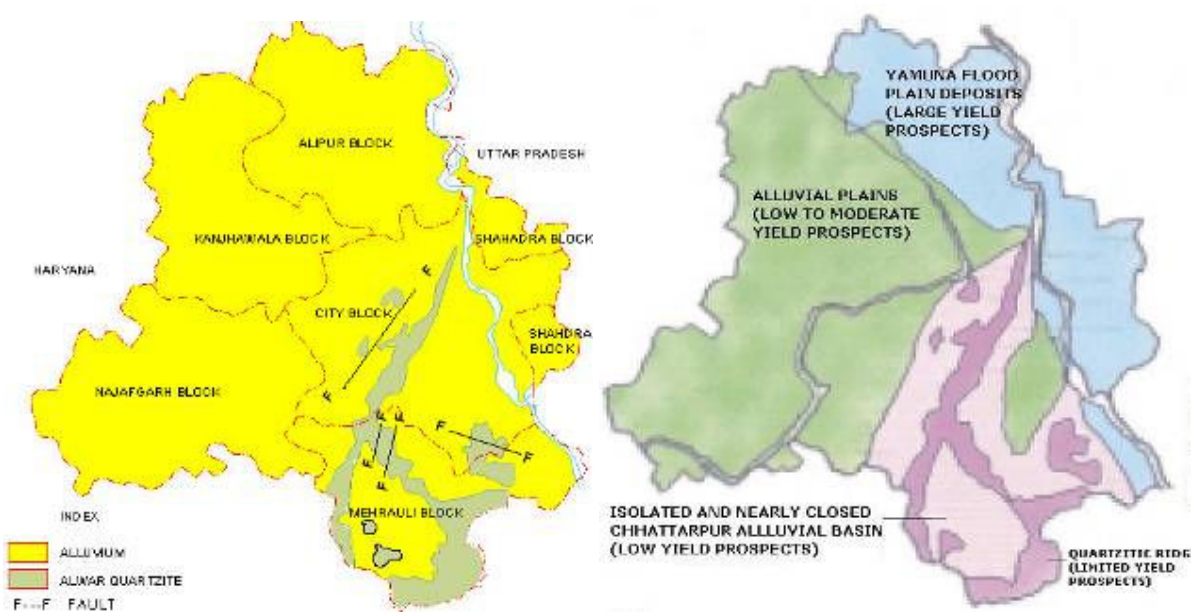
It was in 1970 when the Central Road Research Institute (CRRI) after an exhaustive study on traffic and travel characteristics of Delhi recommended a Mass Rapid Transit Network for the city. Implementation started when the *Delhi Metro Rail Corporation Ltd.* under the Companies Act, 1956 was set up in May 1995. Physical work on the project started on October 1, 1998.

3.1.3. Climate

The climate of the Delhi region is semiarid type, with three well defined seasons. The cold season begins at the end of November, and extends to in early July and continues upto September. The hot summer extends from the end of March to the end of June. The temperature is usually between 21.1° C to 40.5° C during these months. Winters are usually cold and night temperatiures often fall to 6.5° C during the period between December and February. The average annual temperature recorded in Delhi is 31.5° C based on the records over the period of 70 years maintained by the Meteorological Department. The average annual rainfall in the NCT of Delhi is 612 mm. The rainfall over NCT of Delhi generates surface water run-off through streams, drains and as sheet flow. Delhi being highly urbanized the percentage run-off is high due to the extensive paved area. The average annual evaporation is about 2540 mm in Delhi. The mean relative humidity is 66%. The climatic regime of Delhi falls under the semi arid type, as influenced by the considerable distance of the city from the sea and prevalence of continental winds during major portion of the year.

3.1.4. Geology Details

The ground water availability in the territory is controlled by the hydrogeological situation characterized by occurrence of alluvial formation and quartzitic hard rocks.



The Union Territory of Delhi consists of flat and level plains interrupted by cluster of sand dunes and a long continuous chain of rocky ridges. The sand dunes are of varying dimensions and in general trend northeast - southwest. The crests of the dunes generally lie between 6 and 15 metres above the surrounding plains. They are more or less fixed in this area and support vegetation. It appears that they are of longitudinal type and are oriented parallel to the prevailing wind directions.

3.1.5. Drainage

The Yamuna river flowing in a southerly direction in the eastern part of the Union Territory of Delhi is the only perennial river in the area. Eastern and western Yamuna canals and Agra canal are the three major canals which originate from the Jamuna river with Bawana, Rajpur and Lampur distributaries. Auchandi, Budhanpur, Sultanpur Mundka, Mongolpur, Nahari, Dhansa and Surkhpur are some of important minors. The Agra canal originates from Okhla, about 12 km. South of Delhi.

Delhi receives its water from 3 sources:

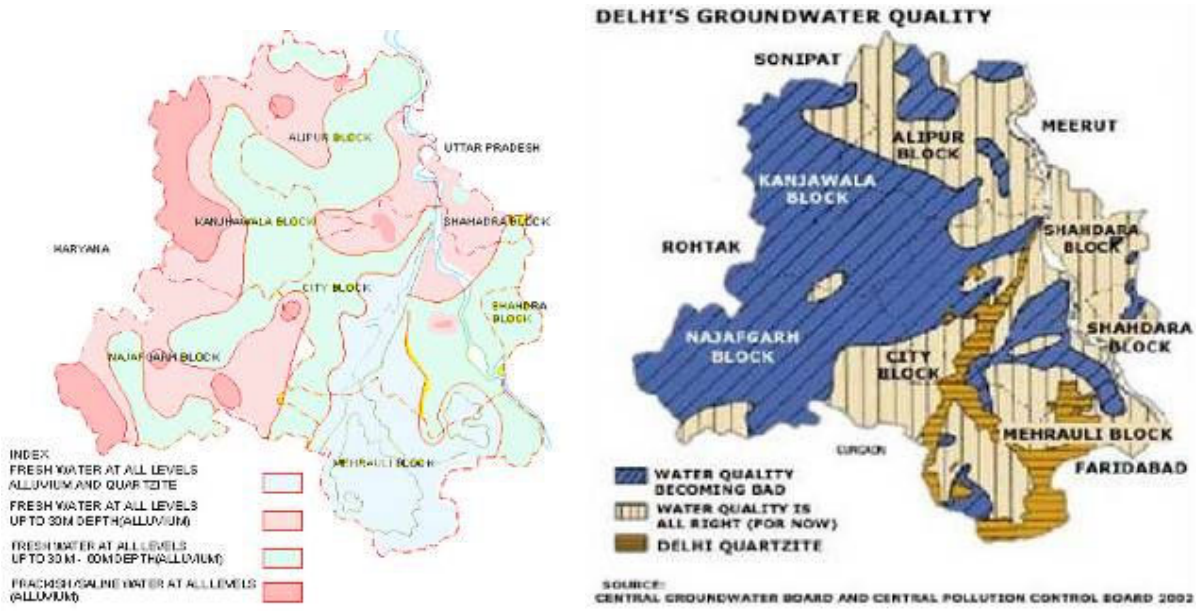
A. Surface Water:86% of Delhi's total water supply comes from surface water, namely the Yamuna River, which equals 4.6% of this resource through interstate agreements.

B. Sub-surface water: Ranney wells and tubewells. This source, which is met through rainfall (approx. 611.8 mm in 27 rainy days), and unutilized rainwater runoff, is 193 MCM (million cubic meters).

C. Graduated Resources: It is estimated at 292 MCM, however current withdrawal equals 312 MCM.

Apart from groundwater, Delhi gets its water from the Ganga Canal, the western Yamuna canal, the Bhakra canal and the Yamuna.

Salinity and over exploitation has contributed to depletion and drastically effected the availability of water in different parts of the city. However, according to a report released by the Central Ground Water Board (GCWB), Delhi's ground-water level has gone down by about eight meters in the last 20 years at the rate of about a foot a year.



The ground water in Delhi has been over exploited. This has disturbed the hydrological balance leading to decline in the productivity of wells, increasing pumping costs and more energy requirement. The groundwater table is Delhi has depleted to 20 –30 metres in various areas across the city. Compared to a level of 30 – 40 feet at the time of Independence, the water table has dropped to 350 feet at certain places. The quality of underground water is also deteriorating and in several places it has been found to tbe unfit for human consumption.

Impact on ground water: Since about 1/6th of the route is underground, it has the impact on ground water. Depletion of the ground water table in and around the area. Additionally, the ground water recharge will be reduced, as the construction of large concrete structures will prevent the percolation of water.

3.1.6. Soil Quality

The soils of the Delhi area are mostly light with subordinate amount of medium texture soils. The light texture soils are represented by sandy, loamy, sand and sandy loam; whereas medium texture soils are represented by loam silty loam.

3.1.7. Vegetation Pattern

Delhi has 111 sq. km of forest cover and 40 sq. km. of tree cover against the geographical area of 1483 sq. km, representing only 10.2% of total land area of the city. The green cover is not uniformly distributed in Delhi as some parts have considerable greenery than the others. The New Delhi and South Districts are much greener compared to other Districts.

The flora of Delhi comprises nearly 1,000 species of flowering plants belonging to some 120 families. Sixty per cent of the species are either indigenous or naturalized and the remaining introduced. More than 50 percent of the indigenous flora represents the tropical species. Nearly eight percent is from tropical Africa less than 50 percent from the New World, and two per cent from the temperate region.

As a consequence of urbanization, much of the naturally existing vegetation has been cleared over the years. The city level forests, the Ridge, the protected and reserved forests have surviving pockets of natural vegetation in Delhi.

3.2. Delhi Metro

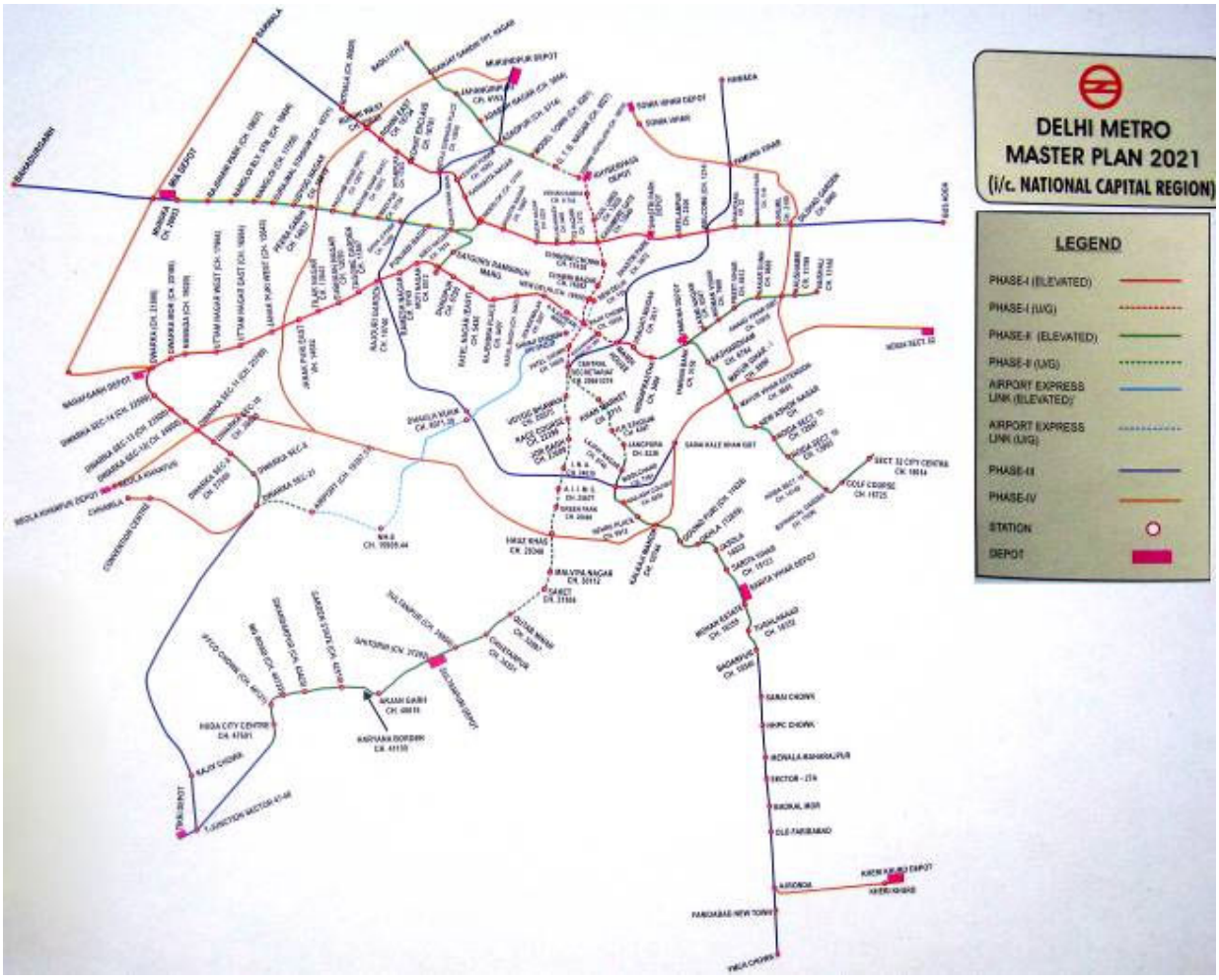
Today, Delhi‘s extended population is approaching 22 million people, and has created crowded conditions with extremely high demands on the public transportation element. This led to the development of the Delhi Mass Rapid Transit System, or Delhi Metro as it is known. The success of this transport network that began operations in December 2002 now sees it as not only the public transportation of choice, but the model itself has become the standard for the development of other systems across India.

Before Metro project Local transport in Delhi was the weakest of all the big cities. Delhi metro with its 190 Kms of network made a difference by connected all the major hubs in the city and its satellite

town of Noida, Gurgaon, Faridabad and Ghaziabad. The development and introduction of MRTS connected these scattered districts with more imageable components. Delhi metro has a current ridership of 1.5 million with the span of 8 years. DMRC operates feeder bus systems from certain metro stations. But access and Dispersal issues has not been considered completely.

3.2.1. From ideas to action: The development of the Delhi Metro took 32 years since a Mass Rapid Transit Network for Delhi was first recommended in 1969-70.
1998 - Work on the Delhi Metro Project started on October 1, 1998.
2002 - The first section of the Delhi Metro (Shahadra – Tis Hazari) opened to the public on December 25, 2002.

Delhi has wide roads (roads cover 23% of the city area) where road possession for construction is not difficult (except in the old city area). Implementation will also not involve demolition of large scale private properties. Most of the land required is under Government control and hence can be easily acquired.
DMRC organized community interaction programs to elicit solutions from the public on various issues.



The entire work of length approximately 413.83 km, planned so far is divided into four phases:

Phase I 65.10 km

Phase II 128.06 km (110.98 km in Delhi + 17.07 in Non Capital Region)

Phase III 112.17 km (62.30 km in Delhi + 49.87 in Non Capital Region)

Phase IV 108.50 Km (97.00 km in Delhi + 11.50 in Non Capital Region)

The phase I and Phase II of the system consists of 193.16 km route length out of which a major portion, i.e. **142.31 km** (125.23 km in Delhi and 17.08 km in NCR) of the system is supported on the viaducts, **6.5km at Grade and 44.35 under Ground.**

Phase I of Delhi Metro Rail project consisted of the following three lines [xxxiii]

Line	Length (Kms)	No. of Stations
Shahdara-Tri Nagar-Rithala	22.06	18
Vishwa Vidyalaya-Central Secretariat	10.84	10
Indraprastha-Barakhamba Road-Dwarka Sub City	32.10	31

Phase II of the Delhi Metro Project consist of the following lines [xxiv]

Line	Length (Kms)	No. of Stations
Shahdara – Dilshad Garden	3.09	3
Indraprastha – Noida Sector 32 City Centre	15.07	11
Yamuna Bank – Anand Vihar ISBT	6.17	5
Vishwavidyalaya – Jahangir Puri	6.36	5
Inderlok – Kirti Nagar –Mundka	18.46	15
Central Secretariat – Sushant Lok	27.45	19
Dwarka Sector 9 to Dwarka Sector 21	2.76	2
New Delhi – Airport	19.20	4
Anand Vihar – KB Vaishali	2.57	2
Central Secretariat – Badarpur	20.04	15

Corridors	Total Length (In Kms)	U/G (In Kms)	Elevated (In Kms)	At-Grade (In Kms)
Dilshad Garden - Rithala	25.09	0.0	20.59	4.5
Jahangirpuri – HUDA City Centre	44.94	23.7	21.24	0.0
NOIDA City Centre - Dwarka Sector 21	49.94	3.13	44.64	2.17
Yamuna Bank – Anand Vihar ISBT Vaishali	8.74	0.00	8.74	0.0
Kirti Nagar - Inderlok – Mundka	18.46	0.00	18.46	0.0
Central Secretariat – Badarpur	20.16	6.1	13.9	0.0
Airport Express Link	22.7	15.13	7.57	0.0
Total	**190.03**	**48.06**	**135.14**	**6.67**

(Source: Towards new horizons, Delhi metro rail corporation ltd.)

Economic Benefits of Delhi Metro in 2011 (as projected by CRRI)

Benefit in Crore Rupees (₹)	Year 2011
Annual Time Cost saved of Metro Passengers	2978.08
Annual Fuel Cost saved of Metro passengers	523.81
Annual Vehicle (Capital and Operating) Cost saved	758.70
Emission Saving Cost	80.92
Accident Saving Cost	27.70
Annual Time Cost saved of road passengers	197.57
Annual Fuel Cost saved of road passengers	23.87
Annual Infrastructure Maintenance cost	314.88
Total cost of all benefits (Cost without discount)	4,905.54

Quantitative Benefits	Year 2011
Daily vehicles of the road	1,59,170
All Accidents saved	660
Fatal Accidents Saved	132
Emissions Prevented	**In Tonnes**
CO2	2,83,717
CO	5456
HC	2376
NOX	1292
PM	182
SO2	13
Total Emission Saved	**2,93,035**

(Source: Towards new horizons, Delhi metro rail corporation ltd.)

S.No.	Parameter	Delhi		
		Transport	Industrial	Domestic & other sources
1.	CO	76% to 90%	37% to 13%	10% to 16.3%
2.	NOx	66% to 74%	13% to 29%	1% to 2%
3.	SO_2	5% to 12%	84% to 95%	Nil to 4%
4.	PM	3% to 22%	74% to 16%	2% to 4%

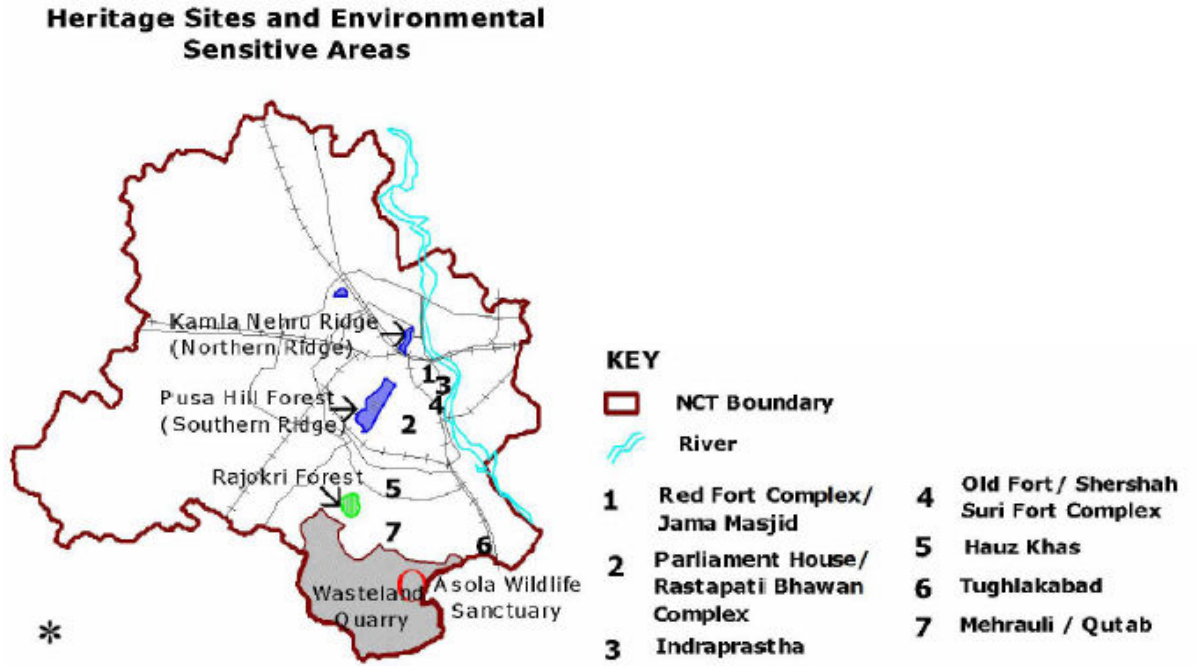
Source: Auto Fuel Policy Report

3.2.2. Network

The Delhi Metro is being built in phases. Phase I completed 65.11 km (40.46 mi) of route length, of which 13.01 km (8.08 mi) is underground and 52.10 km (32.37 mi) surface or elevated. The inauguration of the Indraprastha–Barakhamba Road corridor of the Blue Line marked the completion of Phase I on October 27, 2006. Phase II of the network comprises 128 km (80 mi) of route length and 79 stations, and is presently under construction, with the first section opened in June 2008 and a target completion date of 2010. Phases III (112 km) and IV (108.5 km) are planned to be completed by 2015 and 2021 respectively, with the network spanning 413 km (257 mi) by then.

Current routes: As of February 23, 2011, the whole of Phase-I and parts of Phase-II are complete, with the network comprising six lines with 140 metro stations and a total length of 183.7 km (114.1 mi).

Line	First operational	Last Extension	Stations[23]	Length (km)[23]	Terminals		Rolling stock
Red Line	December 24, 2002	June 4, 2008	21	25.15	Dilshad Garden	Rithala	23 trains[24]
Yellow Line	December 20, 2004	September 3, 2010	34	44.65	Jahangirpuri	HUDA City Centre	45 trains[3]
Blue Line	December 31, 2005	October 30, 2010	44	50	Noida City Centre	Dwarka Sector 21	59 trains[6]
	January 7, 2010	July 14, 2011	6	6.25	Yamuna Bank	Vaishali	
Green Line	April 3, 2010	—	15	18.46	Inderlok	Mundka	13 trains[25]
Violet Line	October 3, 2010	January 14, 2011	15	20.04	Central Secretariat	Badarpur	29 trains[26]
Airport Express	February 23, 2011	-	6	22.70	New Delhi	Dwarka Sector 21	8 trains



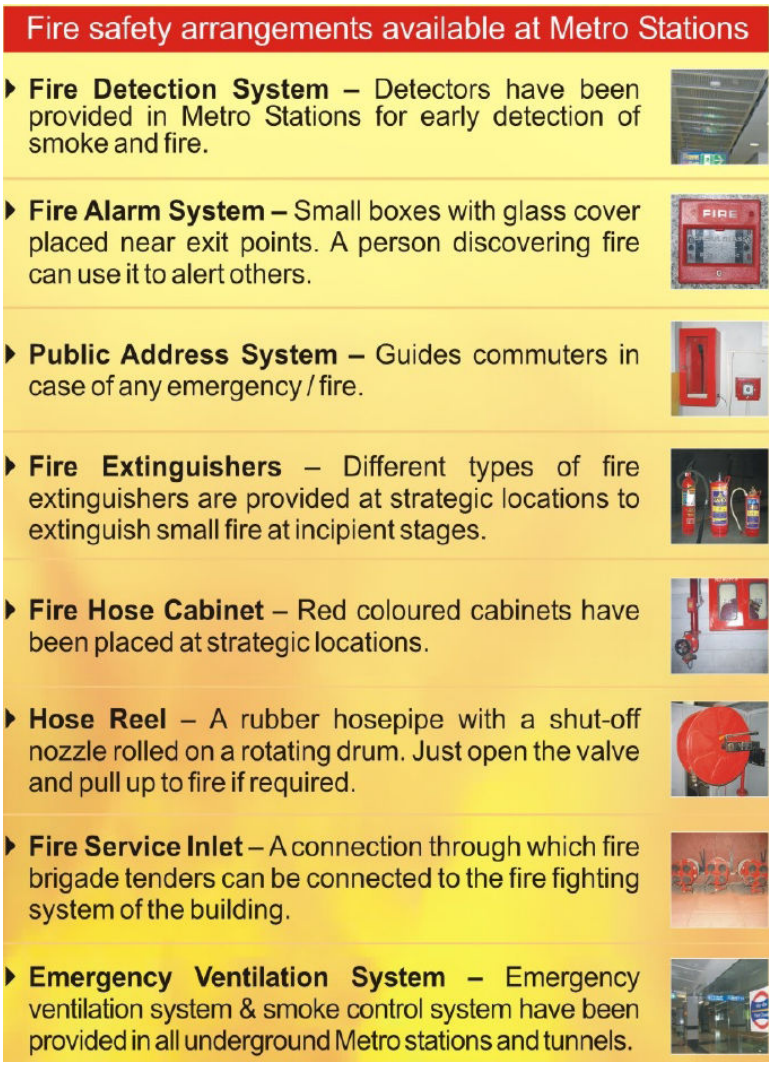
The heritage sites were protected by constructing metro line in underground near the heritage sites.

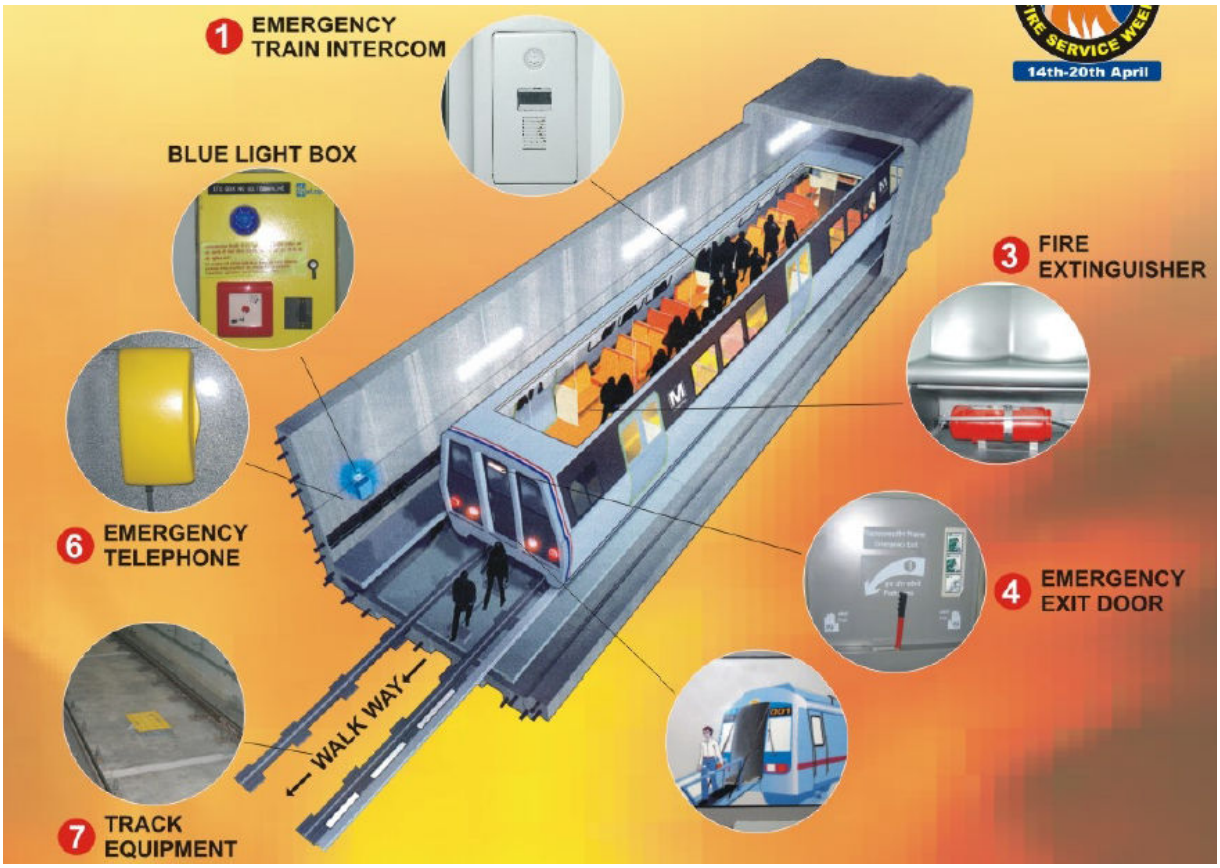
3.2.3. Reduction in the number of vehicles on road: The growth rates of registered cars, two-wheelers, three wheelers, taxis and buses in Delhi are calculated as 9.8, 11, 8, 5 and 7 percent, respectively using data for these vehicles for the period 1971-2002. To calculate the number of vehicles going off the road due to the introduction of MRTS the following exercise is conducted. The registered number of vehicles for each category of these vehicles in Delhi for the period 2002-42 is estimated using the above mentioned growth rates. RITES (1995a) has reported that out of the total registered vehicles, only 28 percent of cars, 40 percent of two-wheelers and 65 percent of taxis and three wheelers are on the roads. It is also reported, depending upon the area and the density of population through which the Metro line passes, that only 30 percent of vehicles on road are influenced by Phase I of the Metro. It is further mentioned that 45 percent of cars, 70 percent of two-wheelers, and 25 percent of buses out of the influenced traffic are diverted to Metro. It is assumed that modes of transport like taxis and three wheelers are on the road by choice and hence they will not be diverted due to the Metro.

3.2.4. Operations: Trains operate at a frequency of 3 to 4.5 minutes between 6:00 and 23:00. Trains operating within the network typically travel at speeds below 80 km/h, and stop about 20 seconds at each station. Automated station announcements are recorded in Hindi and English. Many stations have services such as ATMs, food outlets, cafés and convenience stores. The Metro also has a sophisticated fire alarm system for advance warning in emergencies, and fire retardant material is used in trains as well as on the premises of stations. The first coach of every train is reserved for women only.

3.2.5. Security: Security on the Delhi Metro is handled by the Central Industrial Security Force (CISF). Closed-circuit cameras are used to monitor trains and stations. Security personnel have been deployed to deal with law and order issues in the system, in addition to metal detectors, X-ray baggage inspection systems and dog squads which are used to secure the system. Intercoms are provided in each train car for emergency communication between the passengers and the Train operator.

3.2.6. Issues: As the network has expanded, high ridership and technical snags in new trains have led to increasing instances of overcrowding and delays on the Delhi Metro. To alleviate the problem, orders for new coaches have been placed and an increase in the frequency of trains has been proposed. Infrequent, overcrowded and erratic feeder bus services connecting stations to nearby localities have also been reported as an area of concern.





3.3. Metro makes major impact in Delhi

- Saves 33,000 tonnes of fuel; prevents creation of 2,275 tonnes of poisonous gas.
- According to a new study of Delhi Metro railway, the much talked about mode of transportation has not just made traveling easy and comfortable but also made significant environmental and social impact on the Capital.
- According to Central Road Research Institute (CRRI), the study reveals that the Metro railway has helped save 33,000 tonnes of fuel and prevented creation of over 2,275 tonnes of poisonous gases. Also, it has helped commuters in the city save 66 minutes every day on an average and reduced the daily vehicle demand.
- The Delhi Metro's Phase-I environmental and social benefits will help recover the full cost of this phase by 2013. The completion of Phase-I of the Delhi Metro Project covering 65 km has resulted in reduction in road accidents, improvement in road traffic conditions as also the environment.
- If the social and economic benefits are quantified then the Delhi Metro Rail Corporation has helped the city of Delhi in saving Rs. 1,167 crore already, which will increase to Rs. 2,072 crore by the end of 2007.

- The study highlights that since the Metro rail began operations in December 2002 there has been a progressive increase in the reduction in daily vehicle demand due to people shifting to the Metro rail for commuting.
- Till 2006, the Metro rail has taken the share of 22,697 vehicles and this share is projected to increase approximately to 40,000 for all other modes of travel such as cars, buses, two wheelers and auto-rickshaws by the end of 2007. Correspondingly, 16.6 lakh vehicle km will be saved till 2007 and this is likely to result in a saving of various types such as maintenance cost of road vehicles by Rs. 218 crore, fuel saving worth Rs. 172 crore and saving in road maintenance cost of Rs. 288 crore.
- Pointing out that the Metro railway has resulted in reduced consumption of fuel containing hydrocarbons, the study claims this has resulted in emission savings of 2,275 tonnes. These saving are likely to go up to 3,968 tonnes by the end of this year.
- People in the city save 66 minutes every day on an average by travelling to and fro by the Metro rail, which has resulted in a saving of Rs. 415 crore up to 2006 as their earning capacity time increases.

3.3.1. A policy for protecting environment

DMRC is committed to maintain greenery, nurturing trees and reducing pollution and being environment friendly in every sphere of activity:

- DMRC plants 11 times the number of trees it is forced to cut during construction
- Route alignment had been modified to save about 15% of the trees.
- An innovative contractual provision containing detailed procedure for management of air, dust, water, waste etc.
- Training and awareness to variety of people and organizations associated with this project
- segregation of waste-metal crap, bio-degradable waste etc, at site
- less steel and cement consumption oriented design as both emit co_2during their production

DMRC is one of the most eco –friendly projects undertaken in the country. Here is some of the worldwide recognition of initiatives:

- ISO 14001 EMS (environmental management system) certification during construction
- Golden peacock environment management award 2005
- environment leadership award by the united states- ASIA
- environmental partnership programme in 2004

3.4. Influence zone

Public transport service influence zone is measured from the accessibility. **Since 500 m. is an ideal walking distance, population residing along the metro within walking distance has the highest accessibility to metro.** The area within 500 m from the metro corridor is 31% (198.5 sq.km. out of the 640 sq.km. of total urban area) of Delhi thus, after the implementation of the complete system 69% area of Delhi will remain beyond walking distance of metro. Expansion of metro influence zone beyond 31% will have to rely on feeder system. This is not easy because of the inherent transfer costs and wait times at interchanges.

3.4.1. Delhi metro throwing people in danger:

In at least eight places between Kaushambi and Vaishali stations, The Metro track runs perpendicularly below high-tension wires, making it a death trap.

3.5. Delhi metro accidents

On October 19, 2008, a girder launcher and a part of the overhead Blue Line extension under construction in Laxmi Nagar, East Delhi collapsed and fell on passing vehicles underneath. Workers were lifting a 400-tonne concrete span of the bridge with the help of a crane when the launcher collapsed along with a 34 metres (112 ft) long span of the bridge on top of a Blueline bus killing the driver and a labourer.

A portion of a partially built bridge for New Delhi's metro rail network collapsed July 12, 2009, killing five people and injuring 15. The crash occurred when a metal beam supporting pillars gave way, Concrete slabs came crashing down, burying workers beneath.

On July 12, 2009, a portion of a bridge under construction collapsed when its launching girder lost balance as it was being erected at Zamrudpur, near East of Kailash, on the Central Secretariat – Badarpur corridor. Six people were killed and 15 others injured. The day after, on July 13, 2009, a crane that was removing the debris collapsed, and with a bowling pin effect collapsed two other nearby cranes, injuring six. On July 22, 2009 a steel beam fell on a worker at the under-construction Ashok Park Metro station, killing him. **Over a hundred people, including 93 workers, have died since work on the metro began in 1998.**

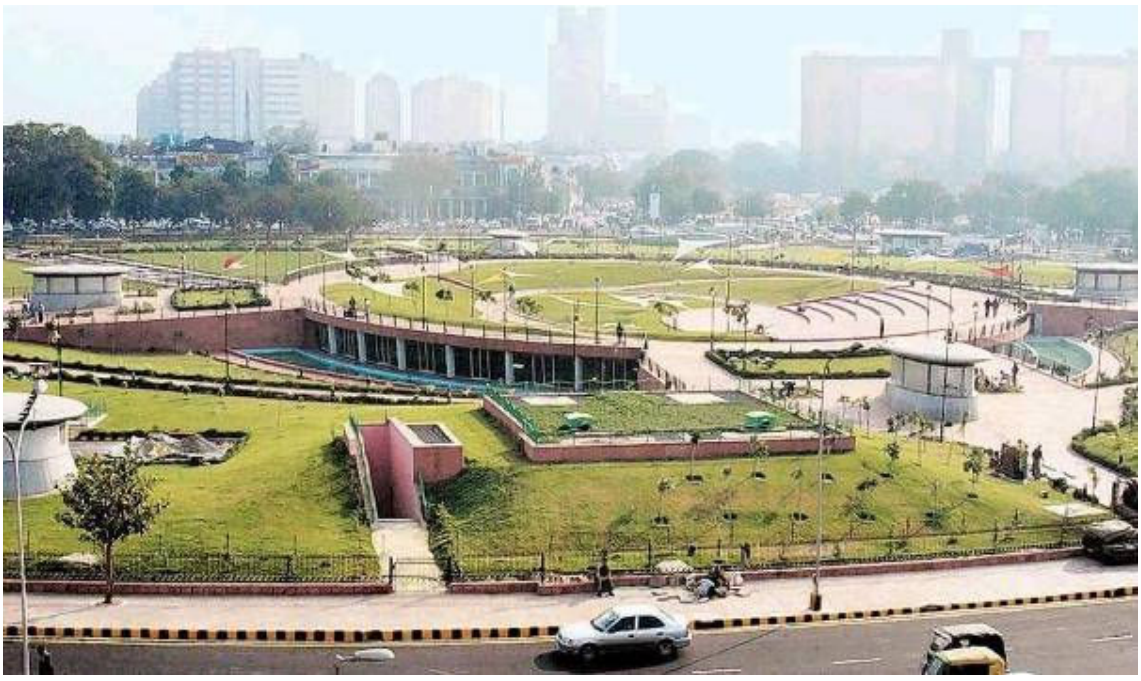
3.6. Delhi Metro Construction Achievements

(Left) Delhi Metro Constructs bridge with 100 metre long Span at Okhla Over Indian Railways Tracks. (Right) 60-metre steel span bridge that has been constructed above the existing Raja Garden flyover on Ring Road-17m from road level-5.5m clearance from flyover deck.

Chawri bazar Metro station was built underground in the congested old Delhi area, and the above old structures were not disturbed during the construction.


Metro rail bridge constructed over existing Indian railways tracks between Pragati maidan and Indraprastha metro stations, with out disturbing the rail tracks even a single day.


Metro track spanning over Ring Road flyover at Rajouri Garden (left). GK Metro station was constructed beside the road as lack of space (Right).



Rajiv Chowk Metro station was built under the central park of busiest business hub Cannaugt place. The station was built underground and the above place was not disturbed during the construction.

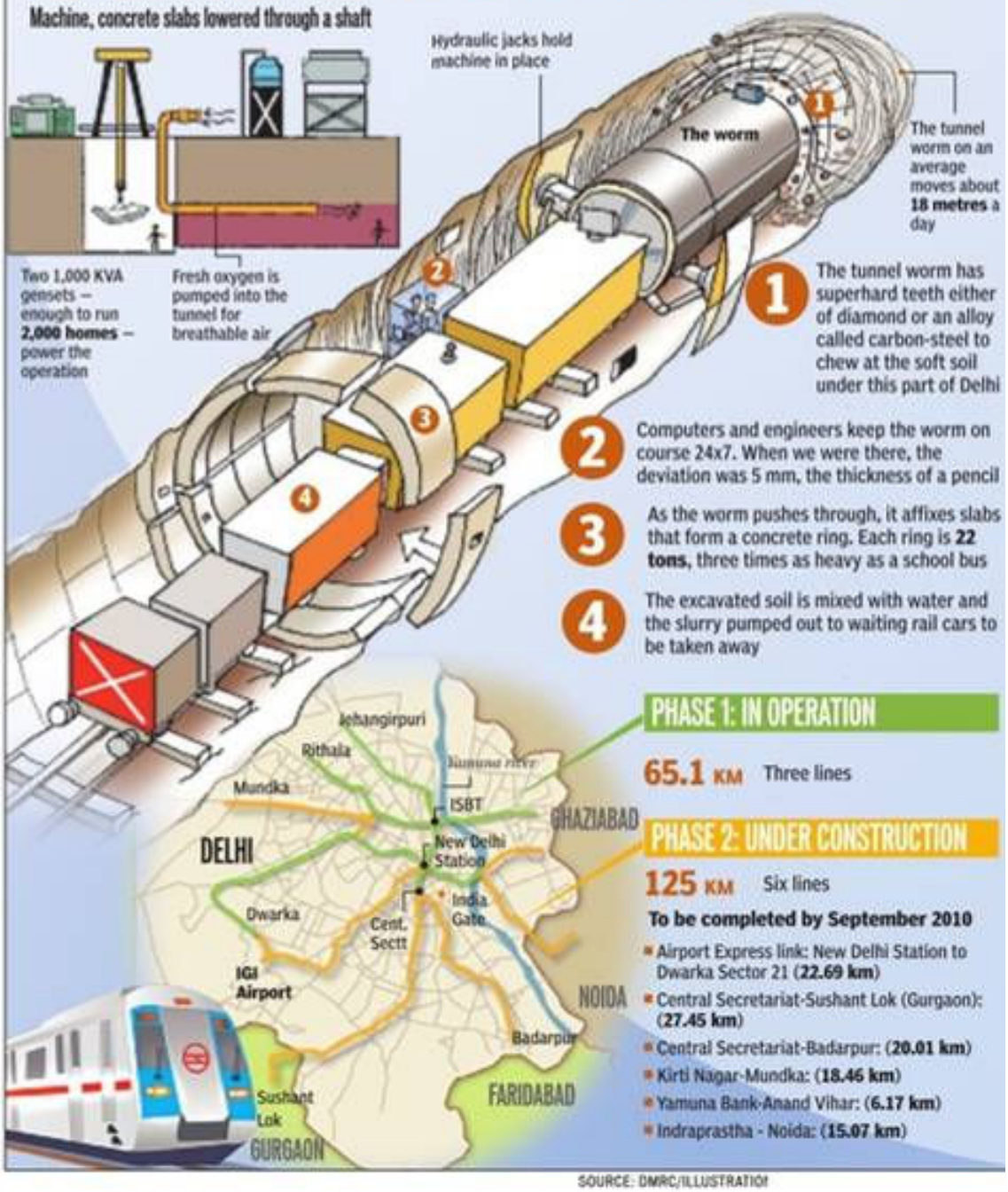
80 metre the length of the tunnel boring machine

The diamond teeth of the tunnel borer, or worm

90 metre the length of a four-coach metro train

The tunnel boring machine was manufactured in Germany, assembled at a plant in Guangzhou, China, then shipped to Mumbai and its parts trucked to Delhi. It was reassembled in three sections underground. Fourteen tunnel borers have worked on the Delhi Metro's phase 2, due to open in September 2010. The worms go down a shaft in three pieces. The final assembly is underground.

Diamonds and dust: How the metro worm works



SOURCE: DMRC/ILLUSTRATION

3.7. Delhi Metro Impact during Construction stage


(Left) Central Secretariat to Badarpur Corridor, (Right) tunnel near the IGI airport Underground corridors being constructed using the classic cut and cover method - It causes lot of dust pollution to the surrounding people. It also disturbs the top soil and natural drainage pattern.


(Left) Kailash Colony station – We can observe huge girders posing threat to the people. There was no proper barricade. (Right) Construction workers temporary housing under the metro corridor construction at Nehru place. It poses danger to the life of workers living in them.

3.8. Delhi metro causing inconvenience


People are waiting in long queues outside Seelampur (left) and Yamuna bank (right) metro stations. The long queues are due to delay in security checks.


Heavy crowds at Rajiv chowk metro station causing delay in travel.


The tunnels formed under the metro stations Udyog nagar (left), Shastri nagar (right) are with very poor light and dark. These areas may become place for the anti social activities.

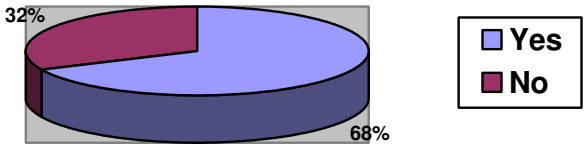
Loosing privacy for houses along metro corridor, and security threat.

3.9. Questionnaire - 3 Survey analysis from the point of People traveling on Delhi metro:

The survey conducted on the sample of **230** people. It is a questionnaire survey, which I did at metro stations of RK Ashram Marg, Rajiv chowk, Barakhamba road, Mandi house, Pragati maidan, Indraprastha, Karol bagh, Kirti nagar, Tagore Garden, Dwarka sector 21, Dwaraka, Janak puri west, New delhi station, Patel chowk, Central secretariat, Nehru place.

Q1. Do you frequently travel on Delhi metro?

Yes 68% No 32%

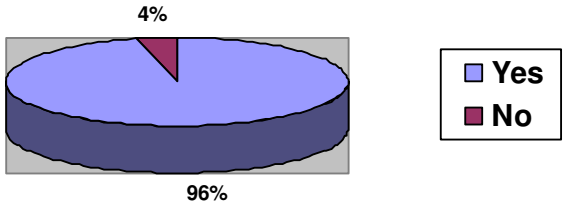


Q2. How many times you travel daily on Delhi metro?

1 time	8%
2 times	54%
3 times	6%
More than 3 times	22%
None of above	10%

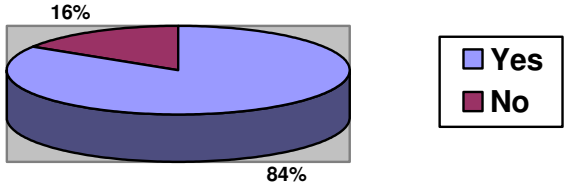
Q3. Do you think Delhi metro solved the transportation problems?

Yes 96% No 4%



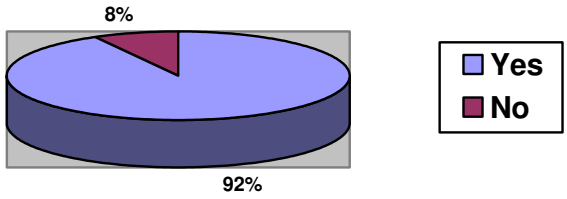
Q4. Do you think Delhi metro reduced the traffic on roads?

Yes 84% No 16%



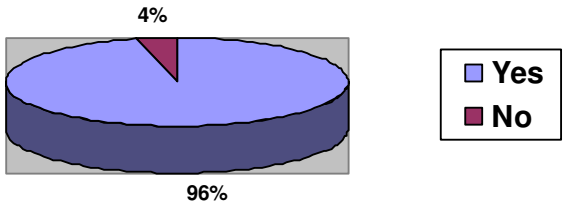
Q5. Do you feel Delhi metro helps in reducing the air pollution?

Yes 92% No 8%



Q6. Are you satisfied with the services of Delhi metro?

Yes 96% No 4%



3.10. Benefits of Delhi Metro

- Reduction of Buses and private vehicles on the roads.
- Increase in the average speed of buses and vehicles on the road from 10.5km/hr to 14 km/hr.
- Saving man hours due to reduced journey time.
- Saving fuel.
- More comfortable and safe travel for commuters.
- Reduction in atmospheric pollution levels.
- Reduction in accident rates.
- Reduced the need for parking spaces, expansion of roads, flyovers, laying of new roads etc.
- Energy requirement per passenger kilometer is one fifth than for other modes

The unique feature of Delhi Metro is its integration with other modes of public transport, enabling the commuters to conveniently interchange from one mode to another.

The corridor will have an ultimate carrying capacity of 60,000 commuters per peak hour per direction. The interchange of commuters between the metro corridors.


Above pictures show the Metro station platforms.


Above pictures show inside the Metro train.


Nehru place Metro station (above left); Train traveling on elevated tracks (above right).

(Below left) Yamuna bank station; (Below right) Central secretariat station.

3.11. Action taken to reduce negative Environment impact during construction

a) The pre-stressing technique, was used extensively on the elevated track to bind the segments, reduces the weight and volume of structure thus correspondingly reducing pollution in manufacturing, transporting, and assembling, etc.

b) Use of high strength concrete to optimum level substantially reduced not only transportation and erection cost but also mitigated pollution. Similarly, by appropriate use of 'pre-stressing' in concrete structure, economy is invariably achieved as there is reduction in volume from 20% to 40% in most of the cases, which in turn results in a positive impact on environmental during construction.

c) Some of the other environmentally friendly construction practices employed during the construction of the metro included

1. Tyre washing facility at site exits,
2. Provision of oil separators,
3. Recycle of bentonite and reuse /recycle of curing waste productive.
4. Use of dewatered water etc.
5. Maintenance of equipment is mandatory and requirements for use of silent DG sets is made more stringent.
6. Segregation of wastes at sites was initiated and handling of waste as per legal requirements was introduced.

3.12. Environment Impacts in the case of Delhi Metro

S. No.	Impacts	Negative Impact		Positive Impact		No Impact
		Short Term	Long Term	Short Term	Long Term	
	Project Location					
i.	Displacement of People		●			
ii.	Change of land use		●			
iii.	Loss of trees/vegetation	●				
iv.	Shifting of utilities	●				
v.	Impact on archeological property					●
	Construction Phase					
i.	Pressure on local infrastructure	●				
ii.	Impact on water Quality		●			
iii.	Impact on air quality including dust generation		●			
iv.	Noise pollution		●			
v.	Traffic congestion and loss of access	●				
vi.	Staking and disposal of construction material	●				
vii.	Public health and safety	●				
viii.	Social impact	●				
	Operational Phase					
i.	Increase in Noise level		●			
ii.	Water Harvesting & Recharge	●				
iii.	Induced Infrastructure development				●	
iv.	Quality of life/ Human use value				●	
v.	Job Opportunities				●	
vi.	Decrease in Air pollution				●	

3.13. Conclusion :

- Businessmen, students and working people are majority users.
- Low income group people are rarely traveling on metro as they feel the fare is high.
- People prefer metro for longer trips as it seems the most feasible for them as the best use of their money.
- Facilities are provided for the differently able and physically challenged people.
- Significant users complain of insufficient parking space at busy stations like Rajiv chowk, Central secretariat and New delhi railway station.
- Majority of users prefer metro over other modes since it takes only 10-20 min for them to reach form origin to destination.
- Higher income group people still prefer to travel on cars as it is more luxury and comfort.

4 CASE STUDY
DELHI METRO STATIONS

4.1. Facilities at Metro stations

Delhi Metro Feeder Bus Service is now available for reaching Metro stations easily & comfortably. Adequate parking is available at stations, if passenger wants to drive to the station.

(Above Left) photograph shows the unorganized parking space outside RK Ashram Marg station. (Above Right) Parking provided above the underground station at Rajiv Chowk.

Security Check-ups

Information & Route map

Token / smart card counters

Automatic Fare Collection (AFC) Gates


Escalators are provided



Wide **Staircases** are provided




Well maintained Platforms with sufficient space for waiting.

Well lit Signage Display. Every where signage are given for the convenience of passenger.

Facilities for the differently-abled: Delhi Metro stations with adequate features for differently-abled persons. The stations have special care for handicaps and senior citizens with escalators and lifts in place. These include extra-wide **automatic flap gates** for wheelchairs, **lifts** with buttons installed at a low level, **tactile paths** for the visually impaired, reserved spaces for wheelchairs in trains, etc.

Fire extinguishers are installed in many locations. **Food court**s also we can find in the station premises.

5 CASE STUDY MUMBAI METRO RAIL

5.1. Mumbai Metro Rail

Greater Mumbai is the financial capital of India and the heart of its commercial and trade activities. Mumbai has the advantage of a high modal share of the public (88%) in favour of a public mass transport system. The existing Mumbai Suburban Railway is carries over 6.94 million passengers every day, and is supplemented by the BEST bus system, which provides feeder services to station-going passengers to allow them to complete their journeys. However, due to the city's geographical constraints and rapid population growth, road and rail infrastructure development has not been able to keep pace with growing demand over the past several decades.

The Andheri-Kurla Road is one of the busiest roads in the country - the Metro will thus be a relief for millions of commuters, especially during the monsoon season, when driving can become highly difficult. There is as yet little clarity regarding plans determining the actual system to be put in place for traffic management, management of passenger inflow/outflow at each station, and vehicle pile-up at each station. This is a critical issue, since the Andheri-Kurla road is often heavily congested, and an addition of people and vehicles without a dedicated management plan would lead to severe traffic jams. The main objective of the Mumbai Metro is to provide rail-based mass transit services to people within an approach distance of 1 to 2 kilometres, and to serve the areas not connected by the existing Suburban Rail network. The Mumbai Metro is to be built in three phases.

Phase I (2006–2016)

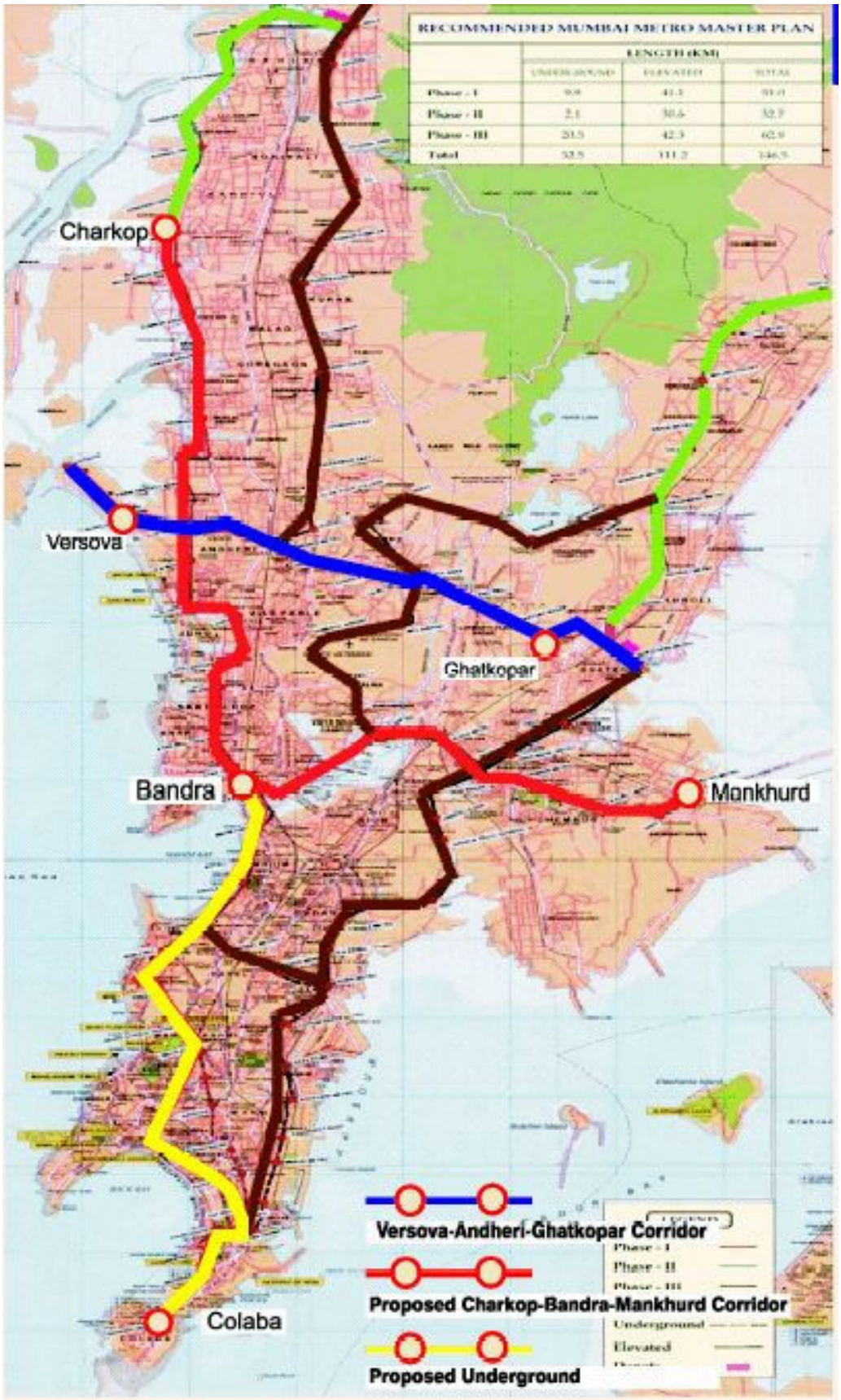
- Versova - Andheri – Ghatkopar - 11.07 km *(Construction started by Simplex Infrastractures Ltd., expected to be complete by 2012)*
- Dahisar (E) - Charkop - Bandra - Mankhurd - 39.2 km

Phase II (2012–2017)

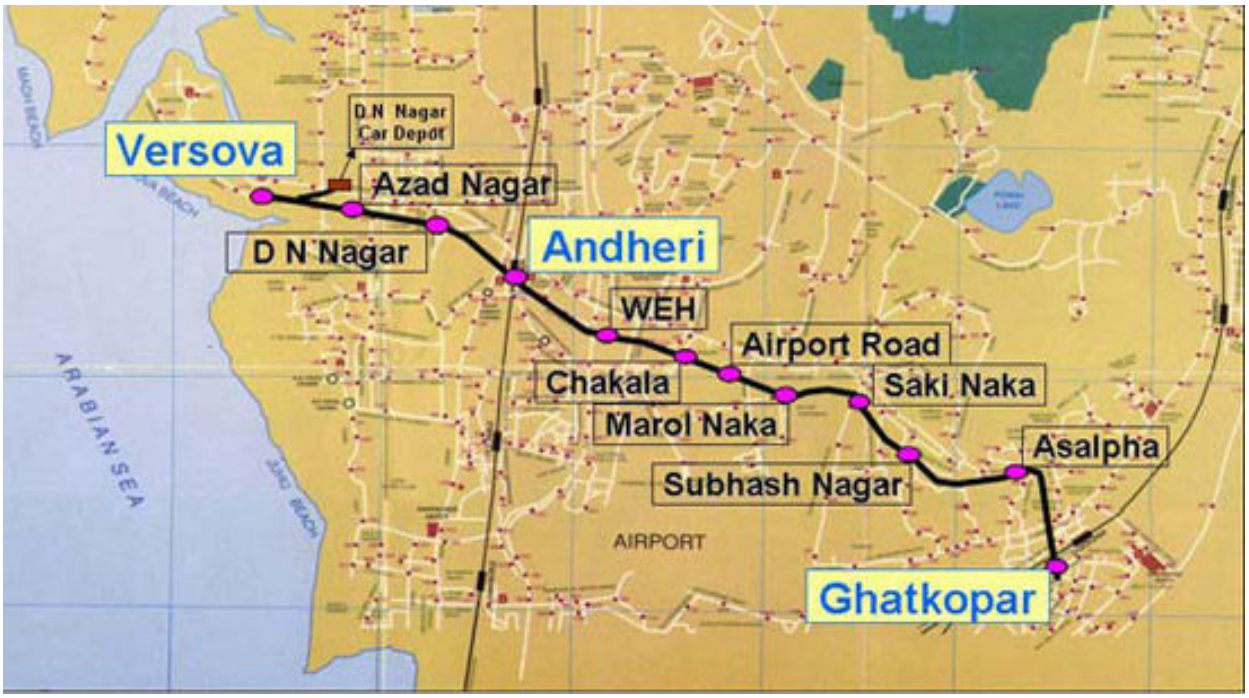
- Colaba - Bandra - Airport - 30 km
- Carnac Bunder-Wadala-Ghatkopar-Mulund-Teen Haath Naka - 40 km

Phase III (2016–2021)

- Airport - Kanjur Marg - 9.5 km
- Andheri(E) - Dahisar(E) - 18 km **Total Length 148.8 km**



Master Plan of Mumbai Metro



5.2. Metro Line 1 : Varsova - Andheri - Ghatkopar Corridor

(11.07 km corridor is under construction)

Project Period: 2007 to 2012

- This corridor connects densely populated areas of western & eastern suburbs and two important suburban railway stations
- It will provide access to important industrial and Commercial areas.
- It will reduce the journey time from 71 min to 21 min between Versova & Ghatkopar
- High ridership forecast of 5,15,000 in 2012 and 8,82,000 by 2031

5.2.1. Challenges during construction

- Working in the middle of a crowded road
- Traffic management
- Underground utilities
- Proximity to the residential, commercial and religious buildings
- Land acquisition and encroachment removal
- Crossing of the Suburban Rail Track and flyover on WEH
- Inter agency coordination
- Availability of land for construction and allied activities
- Availing land for Metro Car Depot

5.2.2. Alignment

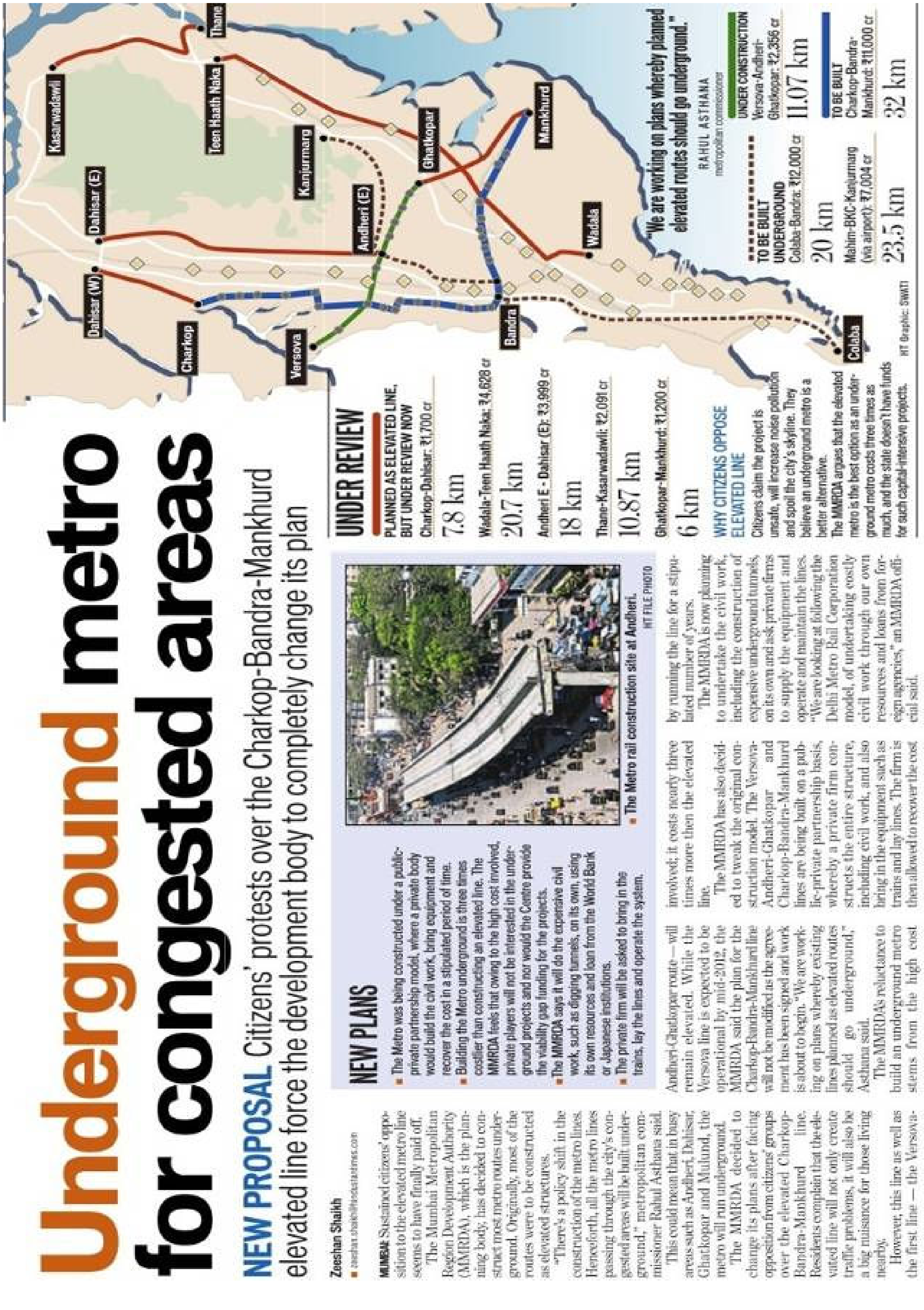
- The Proposed Versova-Andheri-Ghatkopar Metro corridor will be 11.40 Km long double line on elevated viaduct with Standard Gauge (1435 mm)
- Minimum ground clearance : 5.5 m
- The proposed alignment starts at Versova, runs along the JP Road, crosses the SV Road and Western Railway tracks to the North of existing Andheri Suburban Railway Station
- The alignment travels on the MV Road (Andheri-Kurla Road). It crosses the Western Express Highway (WEH) above the existing flyover and reaches Sakinaka
- From Sakinaka the alignment travels along the Andheri-Ghatkopar link Road upto Asalpha
- After Asalpha, the alignment crosses the Kadam Road and runs through Golibar Road upto LBS Marg after taking almost 90 degrees turn behind the Sarvodaya Hospital
- From the LBS Marg the alignment passes along the Heera Chand Desai Road upto Ghatkopar proposed Metro Station near the Ghatkopar Suburban Railway Station
- The take off point for Car depot is located near proposed DN Nagar Metro Station

5.2.3. Civil

- Elevated Viaduct with PSC Segmental construction
- Car Depot at DN Nagar
- Ballastless track
- Operational Control Centre (OCC), Metro Head Office and maintenance depots in the Car Depot premises
- There are twelve stations on the route. They are - Versova, D.N. Nagar, Azad Nagar, Andheri, Western Express Highway (WEH), Chakala, Airport Road, Marol Naka, Saki Naka, Subhash Nagar, Asalpha Road, Ghatkopar

Mumbai, like Bangalore, already has a metro rail under construction. The current discourse tends to focus more on issues such as over-riding of ULBs, controversies regarding land acquisition, worries about cost escalation, and slippages of schedule. The total cost escalation of the project which is now already pegged at Rs. 50,000 crores for the 150 km project. The harm to the urban fabric being caused by the construction being undertaken for the metro (and the skywalks), as it not only leads to visual pollution but also poses severe risks in terms of fire hazards and so on. He said the Mumbai fire department has said that it will not be able to service many buildings that lie very close to the metro line.

(Source: The city and the metro – Report - A National Level Round Table – Pune 2010)



Underground metro for congested areas

NEW PROPOSAL Citizens' protests over the Charkop-Bandra-Mankhurd elevated line force the development body to completely change its plan

Zeeshan Shaikh

MUMBAI: Sustained citizens' opposition to the elevated metro line seems to have finally paid off.

The Mumbai Metropolitan Region Development Authority (MMRDA), which is the planning body, has decided to construct most metro routes underground. Originally, most of the routes were to be constructed as elevated structures.

"There's a policy shift in the construction of the metro lines. Henceforth, all the metro lines passing through the city's congested areas will be built underground," metropolitan commissioner Rahul Asthana said.

This could mean that in busy areas such as Andheri, Dahisar, Ghatkopar and Mulund, the metro will run underground.

The MMRDA decided to change its plans after facing opposition from citizens' groups over the elevated Charkop-Bandra-Mankhurd line. Residents complain that the elevated line will not only create traffic problems, it will also be a big nuisance for those living nearby.

However, this line as well as the first line — the Versova-Andheri-Ghatkopar route — will remain elevated. While the Versova line is expected to be operational by mid-2012, the MMRDA said the plan for the Charkop-Bandra-Mankhurd line will not be modified as the agreement has been signed and work is about to begin. "We are working on plans whereby existing lines planned as elevated routes should go underground," Asthana said.

The MMRDA's reluctance to build an underground metro stems from the high cost involved; it costs nearly three times more then the elevated line.

The MMRDA has also decided to tweak the original construction model. The Versova-Andheri-Ghatkopar and Charkop-Bandra-Mankhurd lines are being built on a public-private partnership basis, whereby a private firm constructs the entire structure, including civil work, and also bring in the equipment such as trains and lay lines. The firm is then allowed to recover the cost by running the line for a stipulated number of years.

The MMRDA is now planning to undertake the civil work, including the construction of expensive underground tunnels, on its own and ask private firms to supply the equipment and operate and maintain the lines. "We are looking at following the Delhi Metro Rail Corporation model, of undertaking costly civil work through our own resources and loans from foreign agencies," an MMRDA official said.

NEW PLANS

- The Metro was being constructed under a public-private partnership model, where a private body would build the civil work, bring equipment and recover the cost in a stipulated period of time.
- Building the Metro underground is three times costlier than constructing an elevated line. The MMRDA feels that owing to the high cost involved, private players will not be interested in the underground projects and nor would the Centre provide the viability gap funding for the projects.
- The MMRDA says it will do the expensive civil work, such as digging tunnels, on its own, using its own resources and loan from the World Bank or Japanese institutions.
- The private firm will be asked to bring in the trains, lay the lines and operate the system.

The Metro rail construction site at Andheri. HT FILE PHOTO

UNDER REVIEW

PLANNED AS ELEVATED LINE, BUT UNDER REVIEW NOW

Charkop-Dahisar: ₹1,700 cr
7.8 km

Wadala-Teen Haath Naka: ₹4,628 cr
20.7 km

Andheri E - Dahisar (E): ₹3,999 cr
18 km

Thane-Kasarwadawli: ₹2,091 cr
10.87 km

Ghatkopar-Mankhurd: ₹1,200 cr
6 km

WHY CITIZENS OPPOSE ELEVATED LINE

Citizens claim the project is unsafe, will increase noise pollution and spoil the city's skyline. They believe an underground metro is a better alternative.

The MMRDA argues that the elevated metro is the best option as an underground metro costs three times as much, and the state doesn't have funds for such capital-intensive projects.

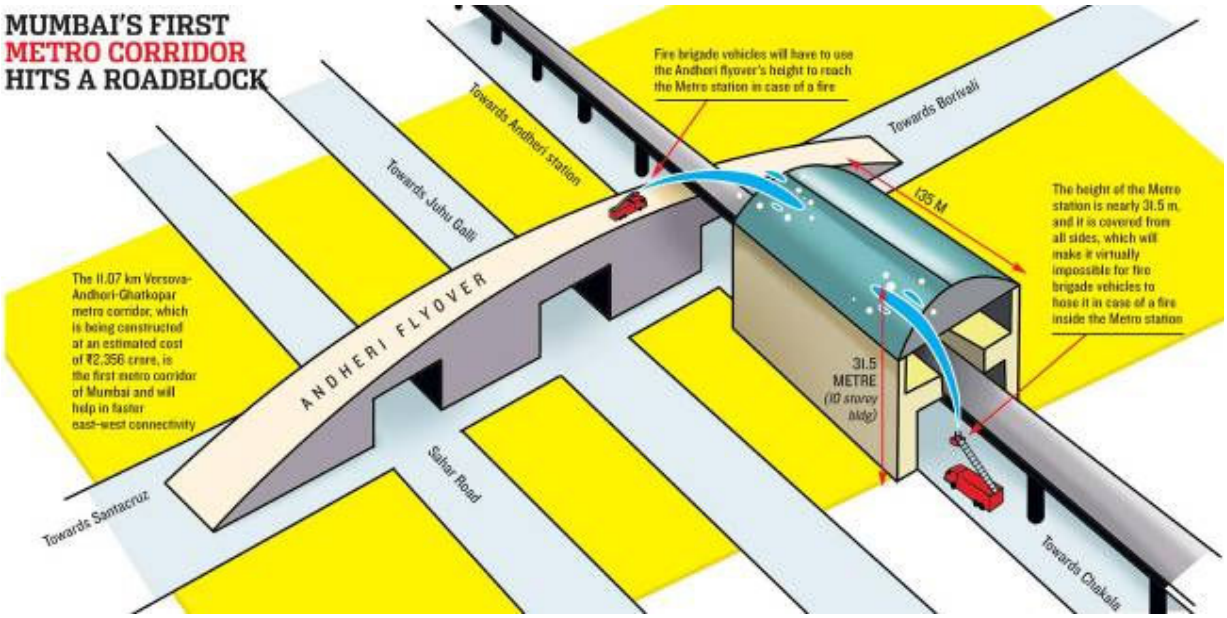
"We are working on plans whereby planned elevated routes should go underground."
RAHUL ASTHANA
metropolitan commissioner

TO BE BUILT UNDERGROUND
Colaba-Bandra: ₹12,000 cr
20 km
Mahim-BKC-Kanjurmarg (via airport): ₹7,004 cr
23.5 km

UNDER CONSTRUCTION
Versova-Andheri-Ghatkopar: ₹2,356 cr
11.07 km

TO BE BUILT
Charkop-Bandra-Mankhurd: ₹11,000 cr
32 km

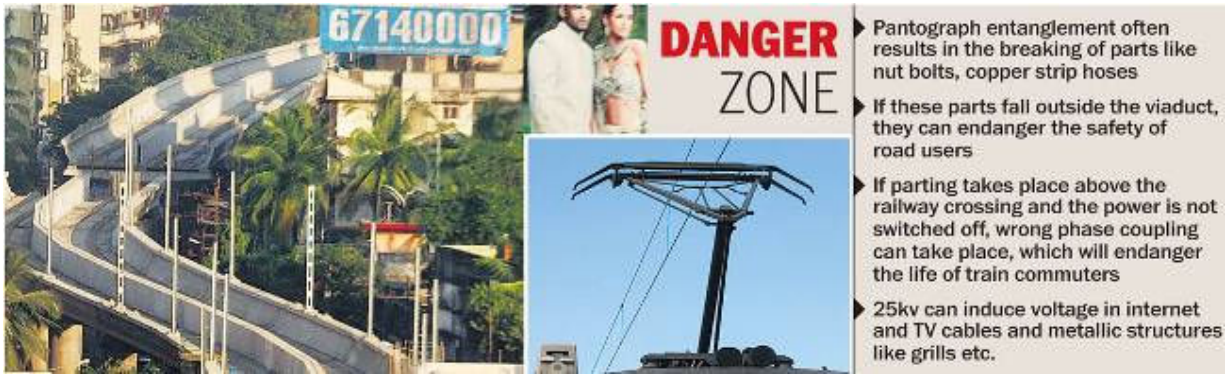
HT Graphic: SWATI



S.No.	Parameter	Mumbai		
		Transport	Industrial	Domestic & other sources
1.	CO	92%	8%	Nil
2.	NOx	60%	40%	Nil
3.	SO_2	2% to 4%	82% to 98%	Nil to 16%
4.	PM	Nil to 16%	34% to 96%	53% to 56%

Source: Auto Fuel Policy Report

Fire department has not given clearance for WEH, the 10 storey metro station, which may end up delaying the Versova – Andheri - Ghatkopar Metro corridor, is being constructed in such a location and has been designed in such a way that it may hinder fire fighting operations. Above illustration shows the details.



Line 1: Versova-Andheri-Ghatkopar

Commencement of work: February 2008

DN Nagar Car depot


(Left) The excavated soil is lying beside the under construction Car depot building, causes **dust pollution** to the people living in the neighborhood. (Right) Road at DN Nagar Depot to Four Bunglow Jn.1 is dug without installing any safety barricades. It poses danger for the people traveling in this direction.

Azad Nagar


From Bhavans College Jn -Azad Nagar station to DN Nagar Ststion. (Right) People and school children **walking on this road are unsafe** as there are **no side barricades** for pedestrians.

DN Nagar


Iillegal encroachment in the construction of the proposed D N Nagar Metro station in Andheri. Children play in the restricted area and very close to the danger zone.

Andheri


Metro Work In Progress at Andheri East. Pedestrians are feeling very inconvenient for walking and **crossing the roads** in this area.


Metro Work In Progress at Andheri East. People are parking the vehicle under the connector bridge.


(Left) Andheri Station Under construction. (Right) Pillars for Rail Over Bridge at Andheri East. Road side petty traders are carelessly occupied the spaces. There are no safety precautions to keep away people from the site of construction.


(Left) Andheri East. (Right) Work In Progress Andheri West JP Road, Navrang Cinema to Bhavans College Jn. The road is very congested and dark.


Work In Progress Andheri West JP Road. People are freely walking under the elevated under construction line as there are no barricades. It is posing very danger to the pedestrians. Hawkers are also occupied the space. People are also parking their vehicles under the metro line.


(Left) Vehicles in the region are being diverted to other roads, because **large sections of J P Road have been blocked** in order to facilitate construction of the Versova-Andheri-Ghatkopar Metro corridor. (Right) Andheri Metro Station. The Station building is being constructing adjacent to Andheri Police Station.

WEH



(Left) WEH Station is under construction. The building materials are lying on the roads and posing danger to people as no proper barricades. (Right) WEH Suspension bridge under construction. The construction is going on without taking safety measures of surroundings; it looks unsafe for the people using this route.

Chakala

(Left) The tunnels under Chakala station are like dark caves, with poor light. There is **no gap maintained** from adjacent buildings. It may pose **security threat, fire hazard** and **less safety**. And also the people **loose privacy** in those buildings.

Airport road

Height restriction is imposed for vehicles. Height of vehicles only up to 4m allowed in this route.

Marol Naka station under construction

Asalpha

Asalpha village station. The road below going to LBS marg **way is closed**. The excavated soil is lying beside the under construction station building, causes **dust pollution** to the people living in the neighborhood.

Ghatkopar


(Left) Ghatkopar station building, (Right)Ghatkopar to Asalpha corridor under construction

5.3. Metro Rail problems

- Residents at Andheri area are fed up of the noise pollution and dust created by the Metro Rail construction work and want better hygiene in the area. Noise pollution, smoke from the vehicles and **dust from the construction work is causing a lot of breathing problems.**

- The excavated holes are a good **breeding ground for mosquitoes**. This is affecting the health of children and they are falling sick more often. The construction work is done in a haphazard manner, many places are **dug up and left open** which can be dangerous. The wires are left loose, so there are **chances of short circuiting**. Traveling has become a major issue now and parking in the area is a bigger problem.

- Very difficult to cross the road especially for children and senior citizens. People **have to stand on the road and wait for buses**. Hence a number of accidents have occurred because of this.

- Debris strewn around and electric boxes left in the open are a big hazard to the welfare of residents. Construction materials are lying in the open without much care, all this finally accumulates into **people having breathing problems**. Also this spreads diseases and currently many people have fallen sick because of the Metro Rail construction.

- The Metro Rail work going on since one and a half year at Andheri-Kurla road. During the day there is no place for parking. It's creating a lot of inconvenience. The Metro Rail construction work has affected the business of shopkeepers since **customers prefer to shop elsewhere**. Since there is **no place for people to walk**, no one wants to come there and shop. The ongoing construction may be beneficial in the future but right now the businesses are affected.

5.4. Environment Impacts in the case of Mumbai Metro

S. No.	Impacts	Negative Impact		Positive Impact		No Impact
		Short Term	Long Term	Short Term	Long Term	
	Project Location					
i.	Displacement of People		●			
ii.	Change of land use		●			
iii.	Loss of trees/vegetation	●				
iv.	Shifting of utilities	●				
v.	Impact on archeological property					●
	Construction Phase					
i.	Pressure on local infrastructure	●				
ii.	Impact on water Quality		●			
iii.	Impact on air quality including dust generation		●			
iv.	Noise pollution		●			
v.	Traffic congestion and loss of access		●			
vi.	Staking and disposal of construction material		●			
vii.	Public health and safety		●			
viii.	Social impact	●				
	Operational Phase (Expected)					
i.	Increase in Noise level	●				
ii.	Water Harvesting & Recharge	●				
iii.	Induced Infrastructure development				●	
iv.	Quality of life/ Human use value				●	
v.	Job Opportunities				●	
vi.	Decrease in Air pollution				●	

6 METRO RAIL IMPACT ON CITY ENVIRONMENT

6.1. MRTS impact on city environment

- Accessibility
- Travel pattern
- Land use
- Land values

MRTS may help for:

- Urban redevelopment
- Vertical expansion
- Commercialization
- Extremely high densities.

Key variables that might contribute to measure changes in local development pattern in response to the transit improvements are:

- Change in accessibility
- Change in property value
- Relationship between land supply and demand
- Availability of other services
- Other market factors
- Public policy / Land use policy

6.1.1. MRTS impact on Urban form & structure:

- Population densities: Population densities tending to increase due to increased accessibility.
- Land use pattern: Commercialization of lands. Sub division of plots
- Activity pattern
- Built form: High rise built form in the vicinity of the station. Un organized built form.
- Traffic flows: New flows and movement patterns with reference to MRTS station.
- Violation in bye laws
- New developments around stations
- Stress on parking needs and infrastructure

6.2. The Environmental impact study

The environmental impact study is prepared based on the prevailing status of environmental, ecological resources and socioeconomic conditions of the population in and around the project area. The observations and survey results were analyzed and the results are used as main tools for planning the project. The planning essentially envisages the following stages of the Metro Rail Project:

i) Design

- Land acquisition and rehabilitation
- Loss of Green Cover
- Landscape and Visual
- Geology and Soils
- Traffic
- Archaeological & Historical monuments

ii) Construction

- Traffic
- Air quality
- Noise and vibrations
- Disposal of excavated earth and water from the tunnels
- Water resources
- Ground water aquifers
- Exposure to hazardous substances
- Safety and Security
- Health and Hygiene at Project sites
- Disposal of demolished building debris

iii) Operation and Maintenance

- Air quality
- Traffic
- Noise and Vibrations
- Energy Resources
- Safety and Security

The mitigation measures associated with each impact is carried out to reduce the impact on environment if the project is implemented.



6.3. Impacts during construction phase

6.3.1. Resettlement

Huge area of land will be acquired. Consequently, many houses, buildings and public facilities will be affected in terms of structure displacement or business and income lost.

6.3.2. Air pollution

Significant in open construction sites such as sub-stations and grade and elevated

Sections due to excavation, construction and transportation activities (i.e. traffic congestion). Especially dust may exceed the standard from 3 to 4 times.

AIR QUALITY VALUES AND CRITERIA

AQI Values	Air Quality Criteria
0 – 25	Clean Air
26 – 50	Light Air Pollution
51 – 75	Moderate Air Pollution
76 – 100	Heavy Air Pollution
> 100	Severe Air Pollution

(Source: CPCB)

6.3.3. Noise, vibration

Noise may be significant impact at open construction sites such as sub-stations and grade and elevated sections due to construction equipment and transportation, especially at night time. National Ambient Noise standards:

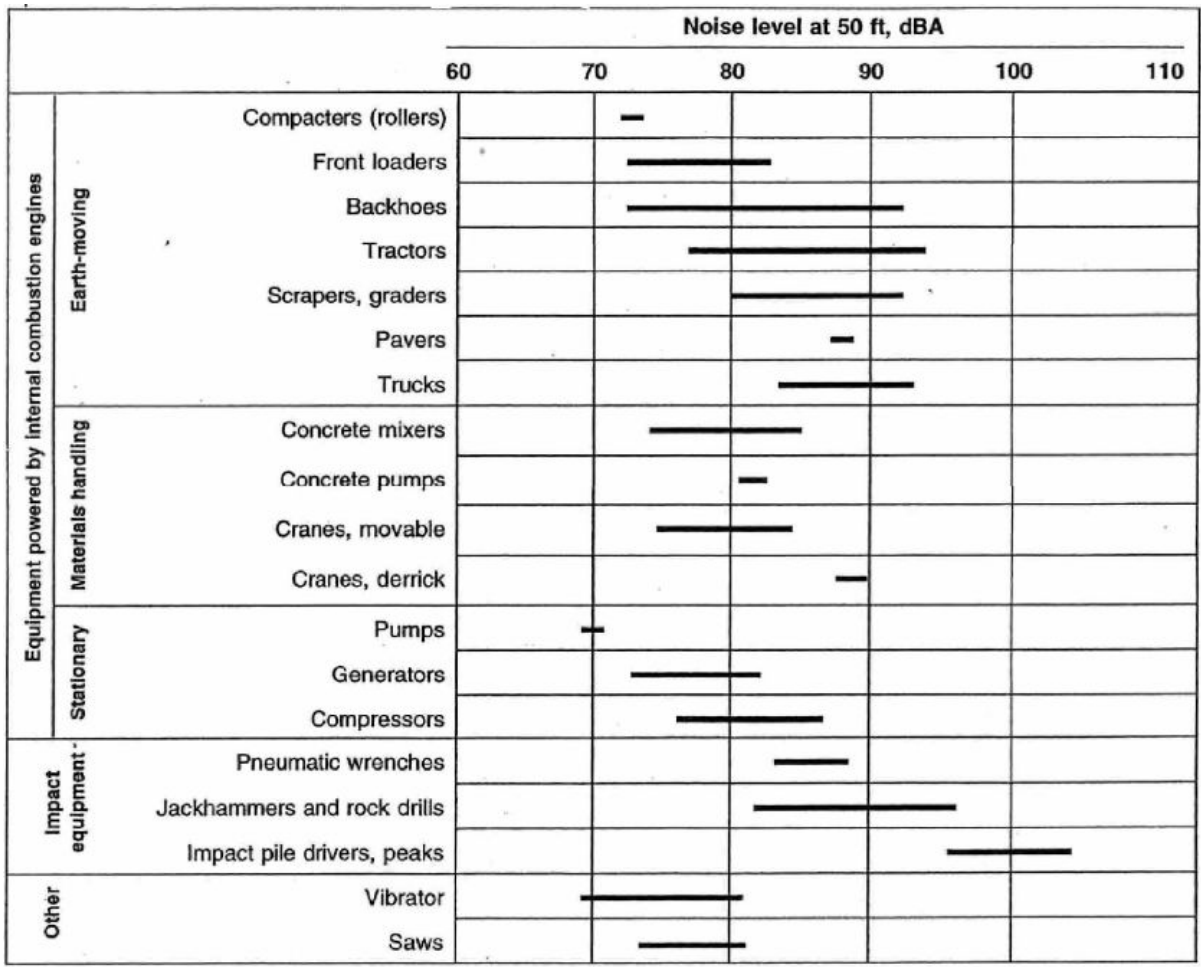
Category of Zones	Leq in dB (A) Day *	Night
Industrial	75	70
Commercial	65	55
Residential	55	45
Silence Zone **	50	40

Source: Central Pollution Control Board

* Day Time is from 6.00 AM to 9.00 PM.

** **Silence Zone** is defined as an area up to 100m around premises of Hospitals, Educational Institutions and Courts. Use of vehicle horn, loudspeaker and bursting of crackers is banned in these zones.

Piling activity and open excavation method (cut and cover) can cause great Vibration and settlement impact on structures.



6.3.4. Community and traffic disturbance

During construction at open sites, part of roads need to be temporarily closed which may cause traffic congestion. Besides, the contribution of transport vehicles serving project will increase the traffic volume along the proposed route.

The construction sites (i.e. sub-stations) may block entrances of community's houses, shops and businesses. The impacts are significant in the areas which have narrow street and busy community and business.

6.3.5. Water pollution

Underground water: The underground water aquifer lies at 20 -50 meters underground, where sub structure of the project have the depths ranging from 15 to 25 meters. Thus, the construction of substructure may pollute and block flow of the underground water.

Surface water: The surface water may be contaminated in terms of run off which contains solid waste and waste water from construction sites and labour camps. No sub –structure cross the river or canals so the direct impact on surface water is not great.

6.3.6. Solid waste

The most significant solid waste is excavated soil (about 1.4 million m3). With huge amount, it is likely to cause significant impact on the environment both air and water bodies. Municipal waste generated from workers' activities in both construction sites and labour camps (approximately 0.3 ton per day) may cause insanitary and disease problems.

6.3.7. Ecology

The number of tree along the proposed routes should be cut down. There is a need to consider the impact of dust from construction sites to ecology along the routes of construction.

6.4. Impacts during operation phase



6.4.1. Air quality

Air quality in the City will be improved once the metro line is operating, as the road traffic reduces.

6.4.2. Water quality

Wastewater sources during operation period are domestic wastewater from train stations along the Metro line, and wastewater (mainly oils and dusts) from the depots as a result of maintenance and cleaning activities. If there are no suitable treatment solutions, the surrounding environment will be affected by these wastewaters.

6.4.3. Solid waste

During the operation period of the Metro line, passengers could generate solid, non-hazardous, food wastes from food establishments, packaging materials from retail facilities, paper, newspaper, and variety of food containers.

6.4.4. Hazardous materials

Hazardous materials, including solvents, loolants, acids, and alkalis, may be used in locomotives and train cars maintenance activities. Polychlorinated biphenyls (PCB) could be found in some electrical equipments (for example: transformers and capacitors), and asbestos could be present in some parts such as wheel bearing and seals for steam engines.

6.4.5. Noise impact

During the operation phase of the Metro line, noises generated from the entire Metro system can be identified as air-borne noise and ground-borne noise.

Air-borne noise: Direct noise in the medium air from the noise source to the receiver is defined as air-borne noise. Generally, railway air-borne noises are generated from:

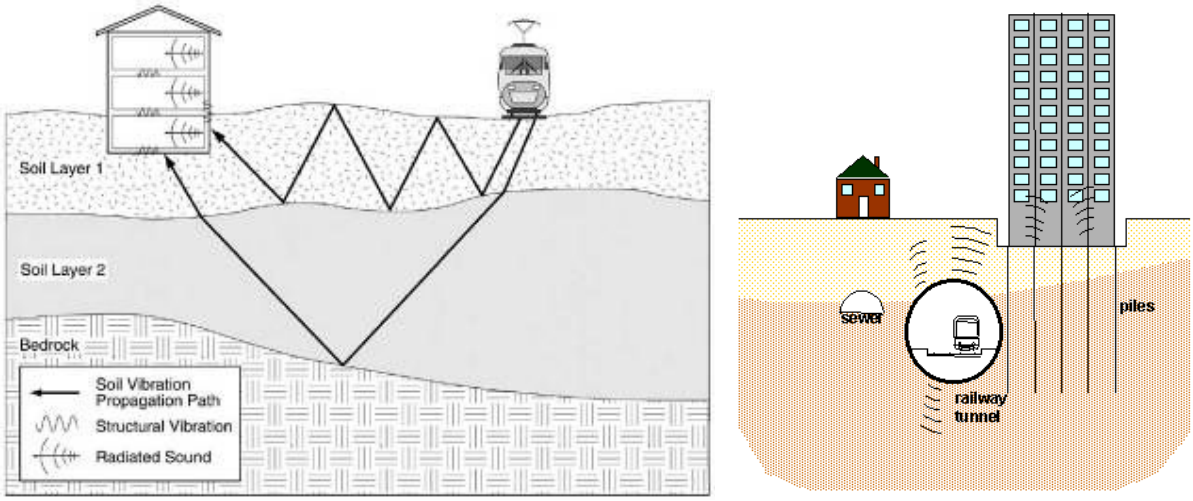
- Wheels rolling over the rails (rolling noise)
- Sharp curves (squeal noise)
- Braking
- Traction motors, ventilators, air-conditioning units

Ground-borne noise: The resulting vibrations of the walls and floors of buildings cause secondary radiation of noise called ground-borne noise. Together with vibration impact, ground-borne noise could have unpleasant impact to inhabitant areas along the underground metro sections if there are no appropriate solutions to tackle the vibration problem.

6.4.6. Vibration impact

In general, vibration impact of the railway system is generated from the pass-by of vehicle on rail, propagated through the ground or structure into a receiving building.

Metro Train Induced Ground Vibrations



Vibrations induced by traffic vehicles running underneath or close to buildings may become considerable. They propagate underground or along the ground surface, and furthermore induce the secondary vibrations of the buildings, which seriously affect the structural safety of the ancient/old buildings and the daily life of the people inside the buildings near the traffic lines. Vibrations due to the passage of trains in tunnels propagate through the soil and produce vibrations and re-radiated

noise in adjacent structures. The traffic flows are getting more and more intense, traffic loads becoming heavier and heavier, and traffic vehicles running faster and faster. All of these make the influences of traffic-induced vibrations more and more serious.

6.4.7. Risks on safety and health

Electric and magnetic fields: railway workers on electric railway system may have a higher exposure to electric and magnetic fields than the general public due to working in proximity to electric power lines.

6.5. Environment Impacts of Metro Rail

Aspect of Environment	Likely Impacts
A. LAND ENVIRONMENT	
Construction Phase	- Increase in soil erosion due to construction activities - Pollution by construction activities - Use of land for labour facilities - Solid waste from labour facilities
B. WATER QUALITY	
Construction Phase	- Surface runoff from project site - Oil/fuel and waste spills - Sewage Discharge from labor camps and site office.
Operation Phase	- Oil/fuel and waste spills - Discharge of sewage
C. AIR POLLUTION	
Construction Phase	- Dust generation from construction activities - Air pollution due to increased vehicular movement -Fugitive emissions from various construction equipments.
Operation Phase	- Increased emission due to vehicle movement and DG set
D. NOISE POLLUTION	
Construction Phase	- Noise due to operation of various equipment - Noise due to construction activities - Noise due to increased vehicular movement
Operation Phase	- Noise from vehicle movement
E. TRAFFIC PATTERN	
Construction Phase	- Traffic congestion on roads due to construction material truck movement - Traffic diversion to other routes due to congestion - Slow movement of vehicles on roads
Operation Phase	- Improved traffic movement
F. SOCIO-ECONOMICS	
Construction Phase	- Increased job opportunity - Increased commercial activities - Displacement of people along the metro routes
Operation Phase	- Increased revenue - Real estate value enhancement and increased commercial activities - Increased job opportunities

6.6. Pollution sources and characteristics

S.No.	Activity/Area	Pollutant	Pollutant Characteristics	Frequency
CONSTRUCTION PHASE				
1	Ground working and leveling	Air emissions-SPM, PM10, CO, NOx,SO2	Dust from construction activities and excavation. Particulates, NOx and CO from vehicle exhaust	Temporary during construction phase only. Bulk of the emissions are expected from earth work activities.
		Earth/Solid waste	Solid waste from construction activity and excavation	Periodic
		Noise	Noise generated from construction equipment and machinery	Temporary, during initial construction phase
OPERATION PHASE				
1	Vehicular movement	Air emission and noise	Vehicle exhaust emissions	Continuous/periodic
2	Diesel power generators	Air emission	SO2,NOX,SPM,CO from fuel burning	Intermittent/periodic
		Noise	Noise due to running of equipment	Intermittent/ periodic
		Hazardous waste	Used oil generation	Periodic, during oil changes
3	Office area	Sewage	Domestic wastewater-BOD, Suspended solids, pathogens	Continuous
		Municipal solid waste	Bio-degradable and non-biodegradable	Continuous
4	Sewage treatment Plant	Solid waste	Settled and stabilized sludge	Continuous
		Treated water	Treated sewage used for horticulture	Continuous
5	Diesel storage	Oil	Oil spillage-Accidental large spills due to pipe rupture Oil spillage-small quantities due to small pipe leaks	Accidental/only due to poor housekeeping
6	Maintenance/ housekeeping	Wastewater	Floor washing and garden wastes	Continuous
7	Air conditioners	Solid waste	Used equipment, parts	Intermittent
		Air emission	Ozone depleting substance release	Accidental
8	Vehicular parking area	Oil spills	Minor oil leaks from vehicles in parking lot	Continuous – small quantities
9	Storm water drains	Wastewater	Contaminated discharge from site – mainly suspended solids	During rainy season

6.7. Enviromental Issues Involving Mass Transit

- The environmental issues that must be addressed when designing new transportation facilities. Transportation issues extend to pedestrian and bicycle circulation.
- Neighborhoods should not be divided and quality of life should be improved.
- Pro-vision of rapid access to the city center, to education, shopping, recreation, and to government services will enhance the quality of living.
- The Metro line at 6m height from road level, creating a visually ugly cityscape. Visual and Aesthetic Conditions should be controlled by design.
- Electric trains such as Metro Rail pollute far less than buses if the electricity is produced by burning oil or coal, and the pollution is concentrated at power-generating plants rather than being spewed along the course.
- Water Resources and Water Quality are matters of concern where a transportation facility crosses or passes near a floodplain or wetlands.
- Historic, Archeological, and Cultural Sites must be protected.
- Further major demolition of existing structures and acquisition of land for stations displacing people, affecting very old heritage structures.
- The road users are endangered by the running train overhead, which on escaping from the rail guidance, derails and have potential to destroy vast properties and many lives using the road.
- The noise pollution of the trains is factor adversely affecting the quality of life.
- The elevated metro rail cannot take care of trucks and cargo supplies within the city and the problems of transporting the refuse using road based vehicles continue.
- Central lane BRT will become impossible
- Stations will have to be created at distances of every one km. As per plans, these will be 30-36 meters wide, 140 meters long and 15- 25 meters high.
- Buildings close to the Metro station will face problems of light, ventilation and continuous noise. Access to these buildings will become narrower.
- During the construction citizens will have to suffer re-routing and diversion of traffic. Road condition during rains will be unsafe. Pedestrians will be badly affected. Disabled will be worst hit.

- Older persons, patients, pregnant women, children and pets in houses close to the elevated track will suffer.
- Citizens will suffer loss of livelihood, business, and comfort; and spend more time and money on travel and fuel.
- Hundreds of trees will be cut. Pollution will increase. Open spaces will vanish. View of historical monuments will be affected.
- During operation there will be reduced congestion on road, faster travel, safer travel, reduced fuel consumption, reduced pollution etc.
- The elevated metro will change the road character and the entire streetscape.

6.8. Mitigation Measures during Construction

6.8.1. Air Quality and Dust

- All dusty materials shall be sprayed with water prior to any loading, unloading or transfer operation so as to maintain the dusty materials wet.
- Stockpiles of aggregate or spoil shall be covered and water applied.
- Vehicles delivering loose and fine materials like sand and fine aggregates shall be covered to reduce spills on roads.
- The height from which excavated materials are dropped shall be controlled to a minimum practical height to limit fugitive dust generation from unloading.
- All vehicles, equipment and machinery used for construction shall be regularly maintained to ensure that the pollution emission levels conform to the CPCB norms.
- The random ambient air quality monitoring shall be done to ensure that the significant impacts are being mitigated adequately.

6.8.2. Noise

- Construction shall be carried out in accordance with standard procedures. All plants and construction equipments shall be fitted with noise control measures and shall strictly conform to the MoEF/CPCB noise standards.
- On-site power generator sets shall be covered with an acoustic enclosure and fitted with muffler and shall conform to the noise emission standards.
- Servicing of all construction vehicles and machinery shall be done regularly and during routine servicing operations, the effectiveness of exhaust silencers will be checked and if found defective will be replaced. Vehicles hired for bringing construction materials at site shall conform to the noise emission standards and shall be operated during non peak hours.

6.9. Positive impact of Metro rail

6.9.1. Reduction in Air Pollution:

This is the single most important factor for promoting a better and healthy city and ensuring a better quality of community's health. From the estimates made, the Metro operation can bring down air pollution loads by an average of 30% from the existing situation with an overall improvement in city's air quality. In operation, it is a non polluting and environmental friendly system.

6.9.2. Traffic Decongestion and Road Safety:

While ensuring a rapid, user friendly mode of transportation, the Metro Rail would effectively bring down the congestion problems on city's roads to an extent of nearly 30%. While achieving substantial decongestion of the roads, this will also ensure that the accidents on the roads will be brought down by this much.

Additionally, as significant traffic load will be taken over by the Metro Rail, the vehicle density on the roads will be less thus leading to reduced stress on the road with consequent lease of longer life to the existing road network.

6.9.3. Development of Suburbs:

Introduction of Metro Rails is expected to promote the orderly growth of suburban areas of the city with economic benefits and providing a good infrastructure to the neighboring rural community. An all round improvement in employment opportunities is also anticipated from the study.

6.9.4. Saving Energy:

The reduction of vehicles will manifest in reduced fossil-fuel consumption particularly petrol. Energy requirement per passenger kilometer is one fifth than for other modes.

6.9.5. Extending life of roads:

There will be less strain on the roads and consequently a longer lease of life is ensured to the roads. This will manifest in savings in the state exchequer by reduction in the maintenance demands and expenditure on roads.

6.9.6. Noise Reduction :

Due to reduction in the traffic along the corridors, there will be significant reduction in the Noise levels especially in the corridor routes.

6.9.7. Socio-Economic Benefits:

By increasing the quality of life on Environmental Factors through the above mentioned benefits and overall positive impact on Society (both direct & indirect) the socio economic benefit is positive and significant. The Millions of man-hours saved by travelling Public if quantified in terms of money is substantial and Note-worthy.

6.9.8. Quality of life of citizens improves:

The health of people will be good, because of less air pollution. And reduction of road traffic.

6.10. Negative impact of Metro rail

Apart from the advantages mentioned there are a number of problems and disadvantages surrounding it.

- Dust from the construction work causes a lot of breathing problems.
- Very difficult to cross the road while construction, especially for children and senior citizens.
- The Metro Rail construction work affects the business of shopkeepers since customers prefer to shop elsewhere.
- The ongoing construction may be beneficial in the future but while construction the businesses will be affected.
- The metro rail is not suitable for Cargo or goods transportation.
- The road will be more congested along the metro corridors.
- Paucity availability of land.
- Problems to pedestrians.
- Problems to the residents along the metro corridors as it generate sound pollution and vibrations.
- Land acquisition and rehabilitation of people. The people loose businesses and neighborhoods.
- Many heritage buildings have to be demolished.
- Many public and private properties have to be demolished.
- Many trees have to be cut down along the metro corridor to widen the roads.
- The elevated corridors all along the city will spoil the beauty of the city scape.
- The urban fabric of the city will be changed forever.

6.11. Environmental management plan

Environment- responsibility al impact/issue	Mitigation measure
Pre-construction/Design Stage	
Bio-climatic design aspects	- Energy conservation through provision of energy efficient electrical fittings - Maximize use of natural light through layout and orientation improvement - Use concrete blocks in place of burnt clay bricks
Water conservation	- Reuse treated wastewater for horticulture - Reduce water requirement through water efficient plumbing fittings - Make provision for rain water harvesting - Arrange alternative source of water supply
Reduction in incremental air pollution through traffic management	- Provide subway or Foot over bridges - Provide adequate parking space and circulation areas
Environmental enhancement	Develop green area and landscaping
Fire management	Provide fire fighting facilities as per codal provision
Failure to include environmental clauses in contracts defining the mitigation actions and measurable	Prepare environmental clause for inclusion in special conditions and technical specifications of the contract agreement
Construction Stage	
Recycling of construction waste	Use left over concrete. Mortars, aggregate and sand in base layers of pavement
Air pollution control	- Transport construction material during non-peak hours - Optimize use of construction machinery - Maintain and sprinkle water on haul roads - Plan mixing of concrete at an offsite batching plant
Noise pollution control	- Provide acoustics enclosures for generators - Provide safety equipment to workers - Adhere to maintenance schedule of machinery - Optimize use of machinery - Avoid honking of vehicles
Solid waste management	- Provide sufficient number of garbage bins - Segregate various types of solid waste and dispose/use appropriately - Dispose off safely the empty containers of paints, pesticides and other hazardous waste
Workers health hazard	- First aid facilities at work site. - Provide safe drinking water and adequate sanitation facility for workers
Operation Stage	
Noise pollution control	- Install Scrubber at the outlet of the DG sets. - Use low sulphur fuel for DG sets - Periodic maintenance of DG sets as per defined schedule of manufacturer. - Maintaining proper stack height for DG sets - Create pollution sink and noise barriers through plantation
Solid waste management	- Segregate biodegradable and non bio-degradable waste - Observe good house keeping and periodic maintenance

7 HYDERABAD METRO RAIL

7.1. Hyderabad Metro Rail

Hyderabad Metro Rail Limited is the Government Enterprise, which had initiated the Metro rail project for Hyderabad. **The Project was allotted to L&T company in Public Private Partnership (PPP) mode.** Metro Rail was approved for 71.16 km., covering three high density traffic corridors of Hyderabad. The Metro Rail System has proved to be the most efficient in terms of energy consumption, space occupancy and numbers transported.

Hyderabad Metro Rail project covers three high density traffic corridors of Hyderabad:

(1) Miyapur-LB Nagar (28.87 km - 27 stations)

(2) JBS-Falaknuma (14.78 km - 16 stations)

(3) Nagole-Shilparamam (27.51 km - 23 stations) **Total: 71.16 km; 66 stations**

7.2. Viaduct structure



The proposed viaduct structure for the Hyderabad Metro is a 'U' shape deck carrying two tracks on single pier located on the median of the road. The width of the deck is 9.1 m and the pier will be 1.45 m to 1.6 m diameter. A road clearance of 5.5 m is ensured below the viaduct structure. The foundation shall be open foundation at most of the locations though pile foundation socketed in rock may be necessary at certain isolated locations. The superstructure shall be pre-cast segmental construction which will cause minimal inconvenience to the road users.

HYDERABAD METRO RAIL CORRIDORS
PHASE I

Three Corridors of Metro rail with stations:

S. No	Corridor I (Miyapur to L.B. Nagar)
1	Miyapur
2	JNTU College
3	KPHB Colony
4	Kukatpally
5	Balanagar
6	Moosapet
7	Bharatnagar
8	Erragadda
9	ESI Hospital
10	S R Nagar
11	Ameerpet **(Interchange Corridor 1, Corridor 3)**
12	Punjagutta
13	Erra Manzil
14	Khairatabad
15	Lakdi-ka-pul
16	Assembly
17	Nampally
18	Gandhi Bhawan
19	Osmania Medical College
20	MG Bus Station (Imlibun) **(Interchange Corridor-1, Corridor-2)**
21	Malakpet
22	New Market
23	Musarambagh
24	Dilsukhnagar
25	Chaitanyapuri
26	Victoria Memorial
27	L B Nagar

S. No	Corridor II (J.B.S. to Falaknuma)
1	JBS
2	Parade Grounds **(Interchange Corridor-2, Corridor-3)**
3	Secunderabad R.S
4	Gandhi Hospital
5	Musheerabad
6	RTC ' X' Roads
7	Chikkadpally
8	Narayanguda
9	Sultan Bazaar
10	MG Bus Station (Imlibun) **(Interchange Corridor-2, Corridor-1)**
11	Salarjung Museum
12	Charminar
13	Shalibanda
14	Shamsheergunj
15	Jangammet
16	Falaknuma

S. No	Corridor III (Nagole to Shilparamam)
1	Nagole
2	Uppal
3	NGRI
4	Habsiguda
5	Tarnaka
6	Lalaguda
7	Mettuguda
8	Secunderabad
9	Parade Ground, **(Interchange Corridor-3, Corridor-2)**
10	Paradise
11	Rasoolpura
12	Prakash Nagar
13	Begumpet
14	Ameerpet **(Interchange Corridor-3, Corridor-1)**
15	Madhura Nagar
16	Yusufguda
17	Jubilee Hills Road No.5
18	Jubilee Hills Check Post
19	Peddamma Temple
20	Madhapur PS
21	COD
22	Hitech City
23	Shilparamam

Above pictures show the proposed metrorail at Hitec city and Punjagutta.

Above pictures show the proposed metrorail at Nampally. The elevated structure is spoiling the visual beauty of city scape.

7.3. Media reports

Centre, AP get notice on Metro

no place for history

Tenants oppose sale of land

DC CORRESPONDENT

HYDERABAD

Feb. 13: The Hyderabad Metro Rail authorities are facing a tough situation over the acquisition of properties along the controversial corridor-II from Jubilee bus station to Falaknama.

While the owners are vying with each other to surrender their properties for road-widening for the Metro Rail project with an eye on 'attractive compensation package' offered by the government, the tenants are strongly opposing it fearing loss of livelihood.

Most of the tenants are shopkeepers, particularly in Musheerabad, Chikkadpally, Kachiguda, Sultan-bazaar, Badi Chowdi and Koti. With no growth, the rents have remained unchanged for several years and the land could not be sold as there were hardly any takers. Even if there were buyers the owners were offered low prices.

However, the Metro Rail project came as blessing for these owners which offered 'dual benefits' for them. Getting rid of the tenants and the attractive compensation.

Another attraction for owners is the widening of the road up to 100 ft to take up Metro Rail project from the present 40 ft to 80 ft in these localities.

Once the road is widened to 100 ft, the market value of land in these areas will be doubled. Even if they lose around 30 ft of their property, they will get a compensation as per market rates and they can go for construction of new building in the remaining area since the government has decided to allow them to construct additional floors without seeking any permission.

(Left) Deccan Chronicle – Date 09 feb 2011. (Right) Deccan Chronicle – Date 13 feb 2011

- The Metro rail project has been proposed as the best public transportation project. The article also explaining the routes the project is covering in first phase. It is promised to come up with world class infrastructure facilities.

- The people who are residing and running businesses for decades are opposing to give their lands to the Metro rail construction. Metro rail authorities are facing tough in acquiring land mainly in JBS-Falaknuma route.

TALKS ON WITH RELIGIOUS HEADS ON RELOCATION

635 religious sites in way of Metro Rail

DC CORRESPONDENT

HYDERABAD

Feb. 21: Construction of carriage ways in the Metro Rail corridor route have encountered a hurdle — religious structures. Relocation of religious structures will be the biggest task ahead for the authorities implementing the Metro Rail project.

Of the 635 religious structures, 130 have been initially identified for relocation.

The GHMC additional commissioner, Mr K. Dhanunjaya Reddy, said, "It is a very sensitive issue. So we are conducting negotiations with the religious leaders involved at a local level. These structures will be the biggest obstructions to the carriage ways."

The traffic police has asked the GHMC authorities to form co-ordination committees to relocate the religious structures. The additional commissioner of police (traffic), Mr C.V. Anand says, "These structures need to be relocated. Otherwise they will narrow down the carriage ways and turn them into bottlenecks."

"In the case of roads that are 100 ft or more in width, there are going to be no problems. However, in most places, encroachments have narrowed down the roads," said a GHMC official.

The GHMC, Hyderabad Metro Rail and traffic police, with the help of the law and order police, will be taking up the issue. Recently, two to three committees of religious structures have come out openly for relocation. Police will be taking their help to create awareness among other religious committees.

The Metro Rail project is coming up in the core area of the city with 3 high density traffic corridors — Miyapur-LB Nagar, Jubilee Bus Station-Falaknuma, Nagole-Shilparaman.

METRO PLAN

Comprehensive and integrated traffic solution.

3 high density traffic corridors (71 km) taken up in phase 1.

- Miyapur - LB Nagar. (29.87 km; 27 stations)
- Jubilee Bus Station - Falaknuma: (14.78 km; 16 stations)
- Nagole - Shilparaman: (27.51 km; 23 stations)

Integration/interchange planned with existing rail terminals, MMTS stations and bus depots.

Air conditioned 'Merry go round' feeder buses between Metro rail stations and catchment areas — 'seamless travel' facility — on same ticket

OU staff opposes land for metro

DC CORRESPONDENT

HYDERABAD

Jan. 24: Teachers, students and other employees of the Osmania University have launched a 'Save OU lands' campaign protesting the decision to allot varsity land to the Hyderabad Metro Rail Project.

The teachers and students expressed concern that the land allotments would affect the centuries-old heritage monument, the Koti Women's College and PG College, Secunderabad.

The university has identified nearly 25 acres of its land in six different locations to be allotted to Metro Rail. While two acres have been identified in Koti Women's College, another two acres are located in PG College, Secunderabad.

Similarly, 1.7 acres in NIN premises, Tarnaka, two acres in State Archives, Tarnaka, 2.78 acres in Tarnaka junction flyover and university road and 15 acres near Sarathi School, Habsiguda, has been identified for the purpose.

"The university officials are maintaining complete secrecy with respect to land allotments," said Mr Satyanarayana, president, OU Teachers Association. "There is no transparency. They got it secretly approved in the recent executive council meeting."

He added that the university had not bothered to consult any of the stakeholders in the university while taking such an important decision.

"We will oppose allotments of land to HMR tooth and nail," said Mr Satyanarayana. "The land should be utilised only for expansion of the university to meet the demands of future generations."

He said that the act of giving away precious lands was totally against the resolution passed by the university on December 26, 1986 as well as the report of the Justice O. Chinnappa Reddy Committee.

SULTAN BAZAAR

Underground metro route ruled out

DC CORRESPONDENT

HYDERABAD

Jan. 23: The Hyderabad Metro Rail authorities on Sunday ruled out the possibility of changing the alignment or taking the metro rail through an underground route in Sultan Bazaar area, citing techno-economic considerations.

Instead the HMR offered to pay market value for the properties being affected.

They said this after traders and house owners from Sultan Bazaar, Koti and Badi Chowdi areas demanded realignment or changing the elevated rail into an underground route, at a meeting held jointly by GHMC and HMR authorities. The chief engineer of HMR, Mr Mohd Ziauddin explained the technical non-feasibility of the alternative routes.

(Left) Deccan Chronicle – Date 22 feb 2011, Deccan Chronicle – Date 25 Jan 2011(Above), Deccan Chronicle – Date 24 Jan 2011 (Right)

- There are as many as 635 religious sites are affecting in the way of Metro rail corridor. Initially 130 sites have been identified by GHMC for relocation.

- Osmania University staff and student are opposing to the surrendering of university lands at Koti women's college and PG college at Secunderabad.

- Under ground metro proposal is totally ruled out by Metro rail authorities.

Shop owners of Sultan Bazaar take out a candlelight rally 'Koti Bachao', to protest against the proposed Hyderabad Metro Rail project on Saturday. A large number of shops are to be demolished to make way for the project. — INN

The compound wall and portico of the St Anthony's Church at Mettuguda also known as the miracle shrine is scheduled to be demolished on Friday. — DC

No changes in alignment of Metro Rail

DC CORRESPONDENT

HYDERABAD

March 14: Despite opposition from traders, political parties and activists, the state government on Monday ruled out any changes in the alignment of the Metro Rail project.

Replying to members during the Question Hour, the municipal administration and urban development minister, Mr M. Maheedhar Reddy, said though there were requests in this regard, the government had decided to proceed with the existing alignment.

Deccan Chronicle – Date 13 feb 2011 (Left), Deccan Chronicle – Date 25 feb 2011 (Middle)

- Despite lot of requests and opposition from all people and activists regarding the route change in JBS to Falaknuma route, it has been ruled out.

More lanes sought for traffic post Metro Rail

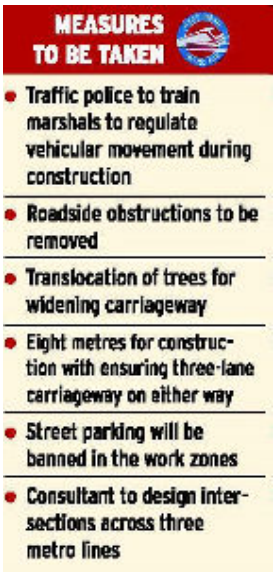
There should be at least two to three carriageways for smooth traffic flow. The carriageways will be developed by removing all encroachments, obstructions etc.

(Left) Deccan Chronicle – Date 21 feb 2011, (Right) Traders protesting against Metro rail project at Sultanbazar on 29th January 2011 .

- Traffic Police are planning to propose to GHMC and Metro rail authorities to develop at least two to three lane roads for smooth flow of traffic.

Alternative route for JBS-Falaknuma metro rail (The Hindu – Date October 30, 2010)

The Hyderabad Metro Rail Limited is ready with an alternative route for line two -- Jubilee Bus Station in Secunderabad to Falaknuma - following representation made by public representatives of the old city seeking a route change. The public representatives wanted the elevated metro rail route covering the old city to avoid a few religious structures like four mosques, four dargahs, two Ashur Khanas and two temples. The changed alignment will now deviate from the originally thought of route at Darulshifa after the Mahatma Gandhi Bus Station, Imlibun and will be built opposite the Salar Jung Museum, High Court, City College and Maternity Hospital alongside the Musi river, Nehru Zoological Park, Idgah, Aliabad reservoir, Kalapather police station and Shamsher Gunj before reaching Falaknuma. Though the elevated metro system was being designed in a manner to avoid causing any obstruction, to any religious or important structures, the alternate alignment was made respecting the sentiments of the public representatives. The changed route also avoids the need for any major land acquisition or demolitions.



Metro rail project not to hinder traffic flow

(The Hindu – Date January 9, 2011)

Hyderabad Metro Rail Limited (HMR) will be taking the assistance of traffic police to train 1,900-odd marshals to be pressed into service to minimise traffic congestions during the construction phase. **There will be physical barrier between all work areas and traffic flows.** As far as possible, piers or pillars will not be built in the middle of junctions and instead there will be wider obligatory spans. A one metre footpath provision is being made all along the work zone. **Street parking will be banned in the work zones** and while there will be no hindrance for public transport buses, other vehicles are to be diverted for about a fortnight or so when the work is in progress at that particular section. Paving unpaved stretches for creation of additional lanes, service roads and parallel roads, road widening, etc., are among the other steps to be taken up. It has listed **219 government and private properties are to be demolished along the way in line one.** Interesting part is the study will assess future flyovers or underpasses at important junctions on line one through which the national highway passes.

7.4. Line-2 (JBS-Falaknuma)

Blue Line: JBS – Falaknuma

Route Length — 14.78 kilometers
Number of Stations (All elevated) — 16
Link to other Corridors (interchange)

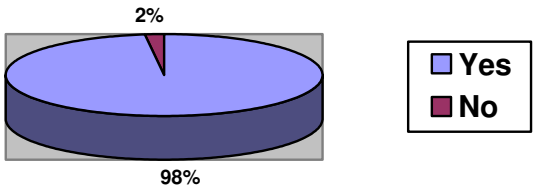
- At Parade Grounds – Connecting Corridors 2 and 3
- At Mahatma Gandhi Bus Station – Connecting Corridors 1 and 2

S.No	Station	Inter Station distance in Km	Chainage in Kilometers From JBS
1	Jubilee Bus Stand	0.000	0.000
2	Parade Ground	0.700	0.700
3	Secunderabad	1.000	1.700
4	MG Hospital	1.246	2.946
5	Musheerabad	0.641	3.587
6	R.T.C. Cross Roads	1.330	4.917
7	Chikkadapalli	0.653	5.570
8	Narayanguda	1.010	6.580
9	Sultan Bazar	0.779	7.359
10	MG Bus Station	0.826	8.185
11	Salarjung Museum	1.390	9.575
12	Charminar	1.540	11.115
13	Shalibanda	0.717	11.832
14	Shamsherganj	0.951	12.783
15	Jangammet	0.926	13.709
16	Falaknuma	0.474	14.183

7.5. Questionnaire - 1 : Survey analysis of the People traveling in Proposed JBS-Falaknuma route (Corridor-II Hyderabad Metro): The survey conducted on the sample of **445** people. It is a questionnaire-1 survey, which I did at Bus stations of MGBS and JBS, Secunderabad railway station, Bus stops in this route and the people traveling on own vehicles in this route.

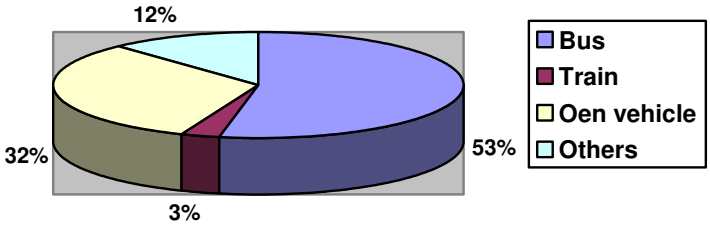
Q1. Did you hear of proposed Metro rail construction in this route as major project?

Yes - 98% No - 2%



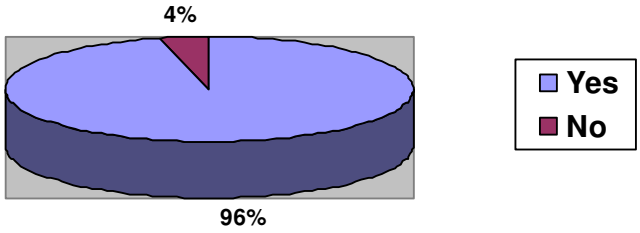
Q2. Which type of transportation you are using for traveling?

Bus - 53% Train - 3% Own vehicle – 32% others – 12%



(Majority of the people feel Bus is convenient and also due to more buses available, less cost)

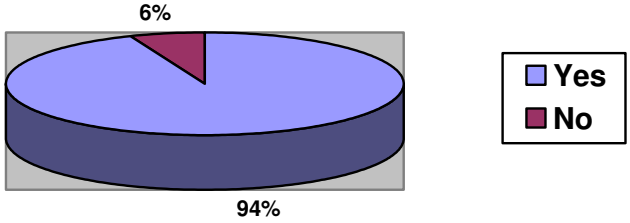
Q3. Do you prefer to travel on metro rail? Yes - 96% No - 4%



(Majority of the people feel, Money saving, Time saving, Traffic can be avoided, Safe journey)

Q4. Do you think Hyderabad city requires Metro rail project to solve traffic problems?

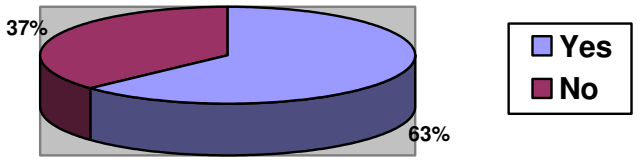
Yes - 94% No - 6%



(Few people suggested to improve the existing transportation facilities, increasing bus services)

Q5. Metro rail runs at the middle of the roads and at the height of 35-50 feet continuously. Do you think it spoils the beauty of the Hyderabad?

Yes - 63% No - 37%



(Few people suggested to go underground to avoid the impact on city character)

Q6. Metro rail stations are built for every 1km on the roads, and they are like series of tunnels to travel on the road. Your opinion:

People answered differently as follows:

(1). Threat of increasing anti social activities

(2). Increase of dust pollution

(3). Accidents may occur due to poor light

(4). Feel inconvenient as dark caves

(5). Security problems may arise like Terrorist attacks

Q7. Your opinion on impact of Metro rail project on Hyderabad city Environment:

People answered differently as follows:

(1).Reduces traffic on roads

(2).People loose businesses and homes in road widening

(3).Reduces air pollution

(4).Safety issues may arise in construction accidents

(5).Employment for many people

(6).People has to suffer during construction

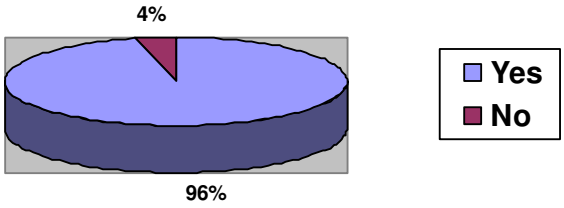
(7).Loss of importance to few landmarks

(8).Loss of trees

7.6. Questionnaire - 2 : Survey analysis of the People living along the Proposed JBS-Falaknuma route (Corridor-II Hyderabad Metro): The survey conducted on the sample of **210** people. It is a questionnaire-2 survey, which I did at areas of Secunderabad railway station, Gandhi hospital, Musheerabad, RTC X roads, Chikkadapally, Narayanaguda, Sultan bazaar, MGBS, Charminar, Shali banda, Shamshergunj, Jungametta, Falaknuma areas

Q1. Did you hear of proposed Metro rail construction in this route as major project?

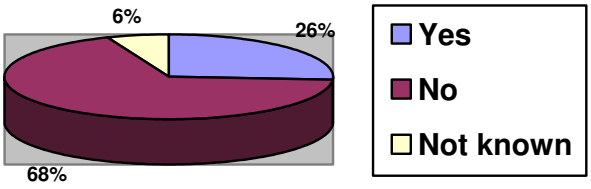
Yes - 96% No - 4%



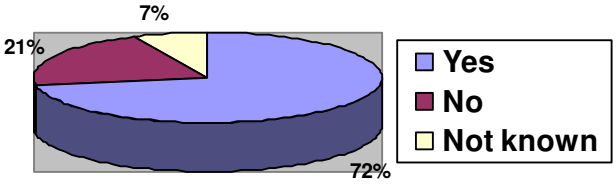
(Few people like shop keepers, petty traders, wage labourers of Shali banda, Shamshergunj, Jungametta, Falaknuma areas are not aware of Metro construction proposal)

Q2. Is your Land / building affecting in Metro rail project road widening?

Yes - 26% No - 68% Not known – 6%



Q3. (For shop owners, shop keepers, petty traders) Do you think your business would be affected because of Metro rail project? Yes - 72% No - 21% Not known – 7%



(The most effecting areas are Secunderabad railway station, RTC X roads, Chikkadapally, Narayanaguda, Sultan bazaar, Shali banda, Shamshergunj, Jungametta)

Q4. What problems you think your neighborhood may face during construction of Metro rail project?

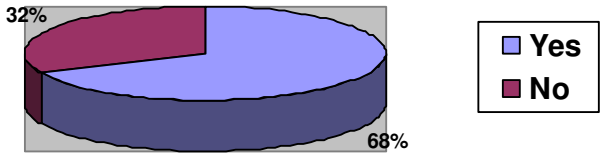
People answered differently as follows: (1).Congested roads(2).People loose businesses and homes in road widening (3).Noise and air pollution (4).People have to suffer during construction

(5).Loss of importance to few landmarks (6).Loss of trees (7).Dust pollution (8).Problems for crossing roads (9).Danger due to heavy construction accidents (10). In case of Traffic diversion, people need to walk long distances for transport.

(Few people suggested to go underground or divertion of route to avoid the impact in congested areas at Sultan bazaar, Narayanaguda, Shali banda, Shamshergunj)

Q5. Do you think your area will be benefited because of Metro rail project?

Yes - 68% No - 32%



(Few people expected to increase in land prices, Better connectivity to other areas, improved business because of good accessibility, Chances of more development and better infrastructure)

7.7. Interpretation:

- The old and pedestrian shopping areas on narrow roads from Kacheguda cross roads through Badi Chawdi and Sultan Bazar (Koti) will have to be demolished in a big way for metro rail construction. These are also high-density residential areas with shops on the ground floor and residences above.
- Mir Alam Mandi Road (Purani Haveli Road) which is a residential area in the old city may not be able to withstand the very force of the construction itself.
- The metro corridor also has to cross railway line at Secunderabad Railway station.
- The metro should be built over flyovers at Parade Grounds and Narayanaguda.
- Metro has to integrate with other corridors at Secunderabad Railway station and MGBS.
- Large scale construction of pillars, corridors and stations will go on for several years in many high density areas.
- The space below the elevated stations will become tunnel like structures with darkness even in day time. They are likely to become areas concentrated in pollution, high noise and of insecurity and crime spots.
- The noise level of up to 85 dB generated by elevated metro rail would seriously damage the peace of the residential and silence zone areas.
- Vertical expansion and morphology of low density structures to high density along the metro corridors. It may happen because of increase in accessibility and increase in FSI in compensation for acquired land.

7.8. Possible Significant Environment Impacts in the case of Hyderabad Metro

S. No.	Impacts	Negative Impact		Positive Impact		No Impact
		Short Term	Long Term	Short Term	Long Term	
	Project Location					
i.	Displacement of People		●			
ii.	Change of land use		●			
iii.	Loss of trees/vegetation	●				
iv.	Shifting of utilities	●				
v.	Impact on archeological property		●			
	Construction Phase					
i.	Pressure on local infrastructure		●			
ii.	Impact on water Quality		●			
iii.	Impact on air quality including dust generation		●			
iv.	Noise pollution		●			
v.	Traffic congestion and loss of access		●			
vi.	Staking and disposal of construction material	●				
vii.	Public health and safety		●			
viii.	Social impact		●			
	Operational Phase					
i.	Increase in Noise level		●			
ii.	Water Harvesting & Recharge	●				
iii.	Induced Infrastructure development				●	
iv.	Quality of life/ Human use value				●	
v.	Job Opportunities				●	
vi.	Decrease in Air pollution				●	

8 SITE ANALYSIS

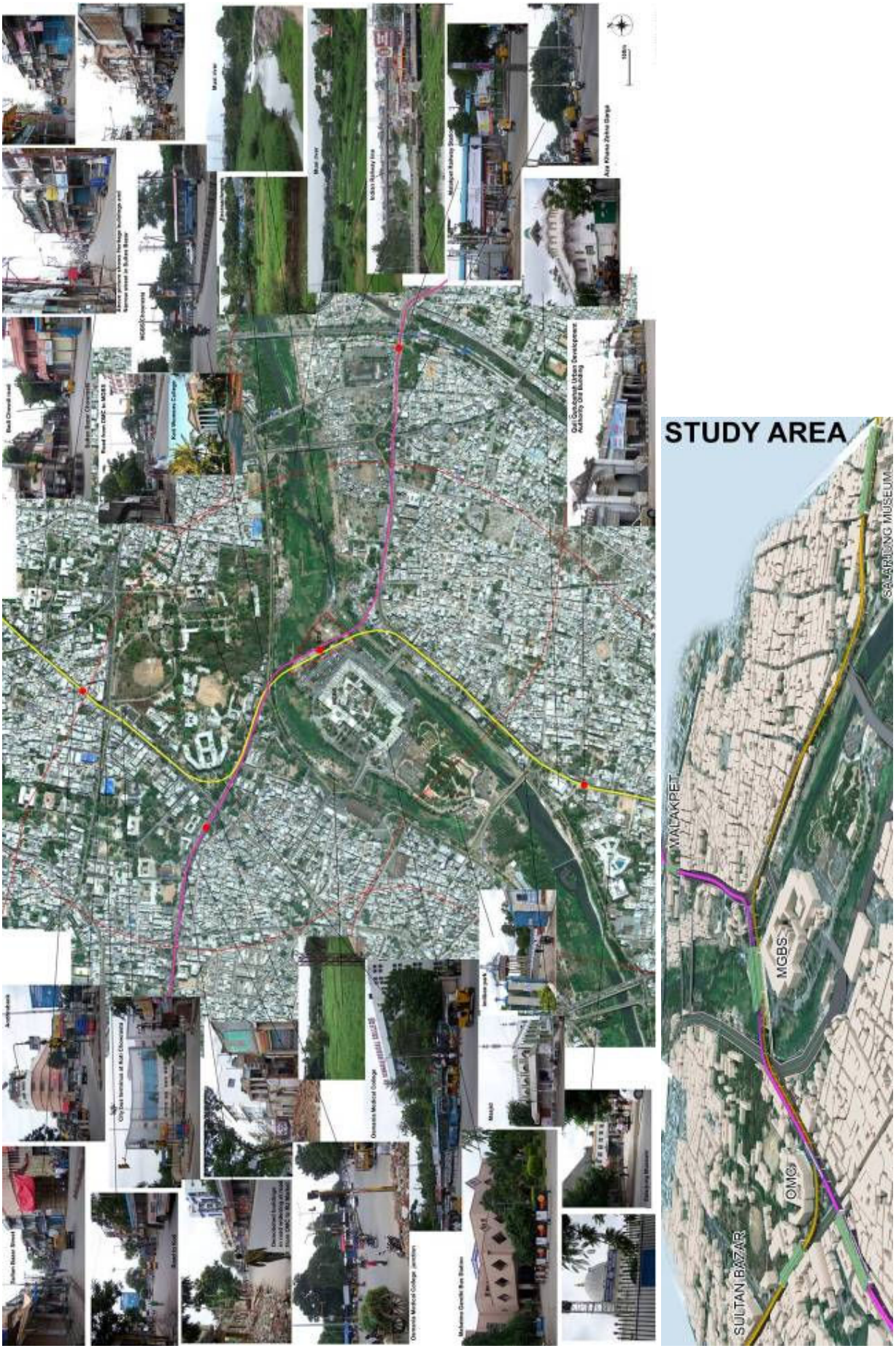
8.1. Site selection

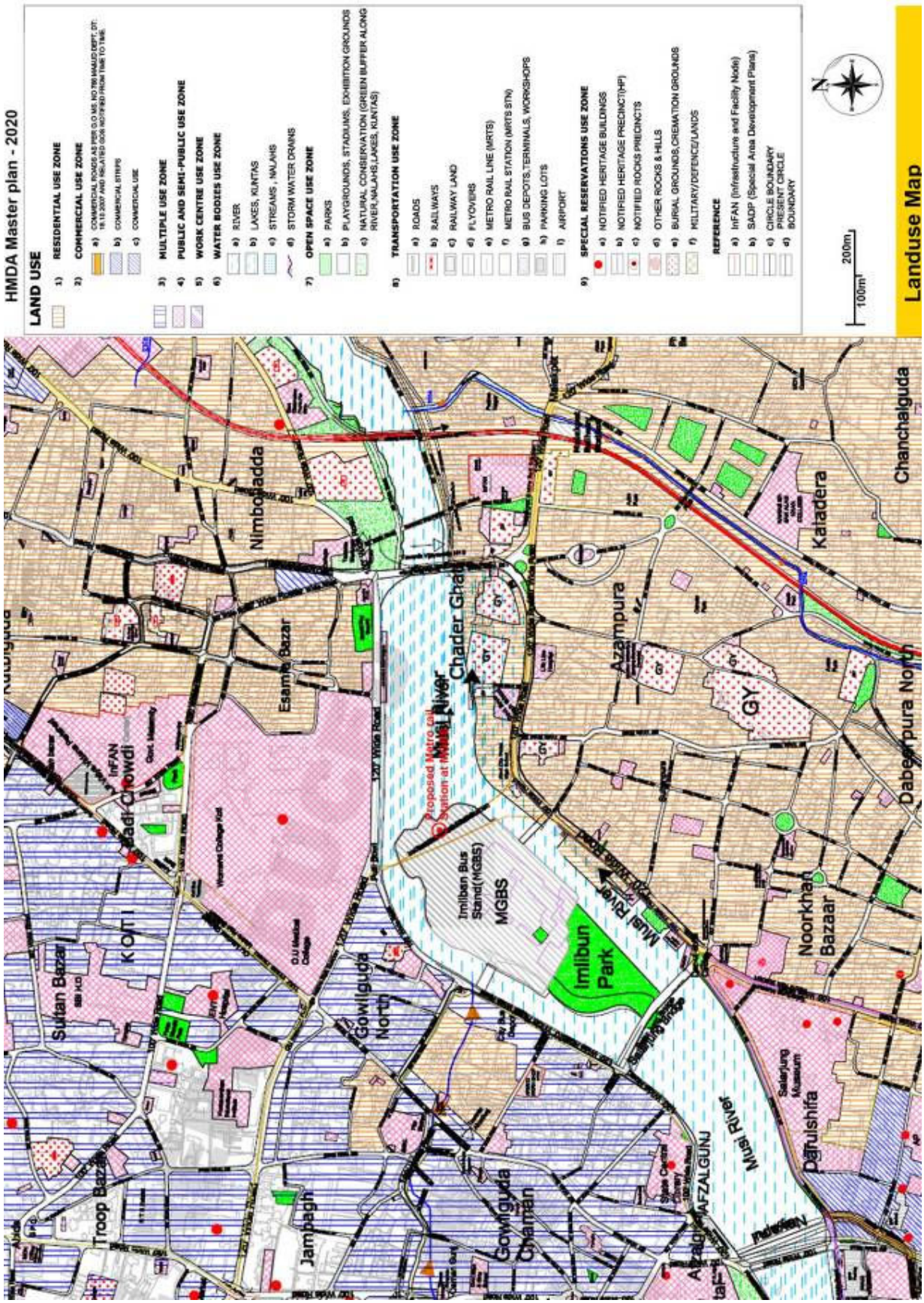
- There are two metro corridors JBS-Falaknuma and Miyapur-LB Nagar intersecting in this area. North-East part of the MGBS bus station island is meant for the construction of interchange metro station, which is in the Musi river. The study area extended to the next proposed metro stations from MGBS, they are Sultanbazar, Osmania Medical College, Malkpet and Salarjung Museum.

- JBS-Falaknuma line is passing through the highly dense, busy and congested areas of Sultanbazar and OMC. This line also passing through the areas of heritage structures, religious structures, landmarks and old constructions having heritage value.

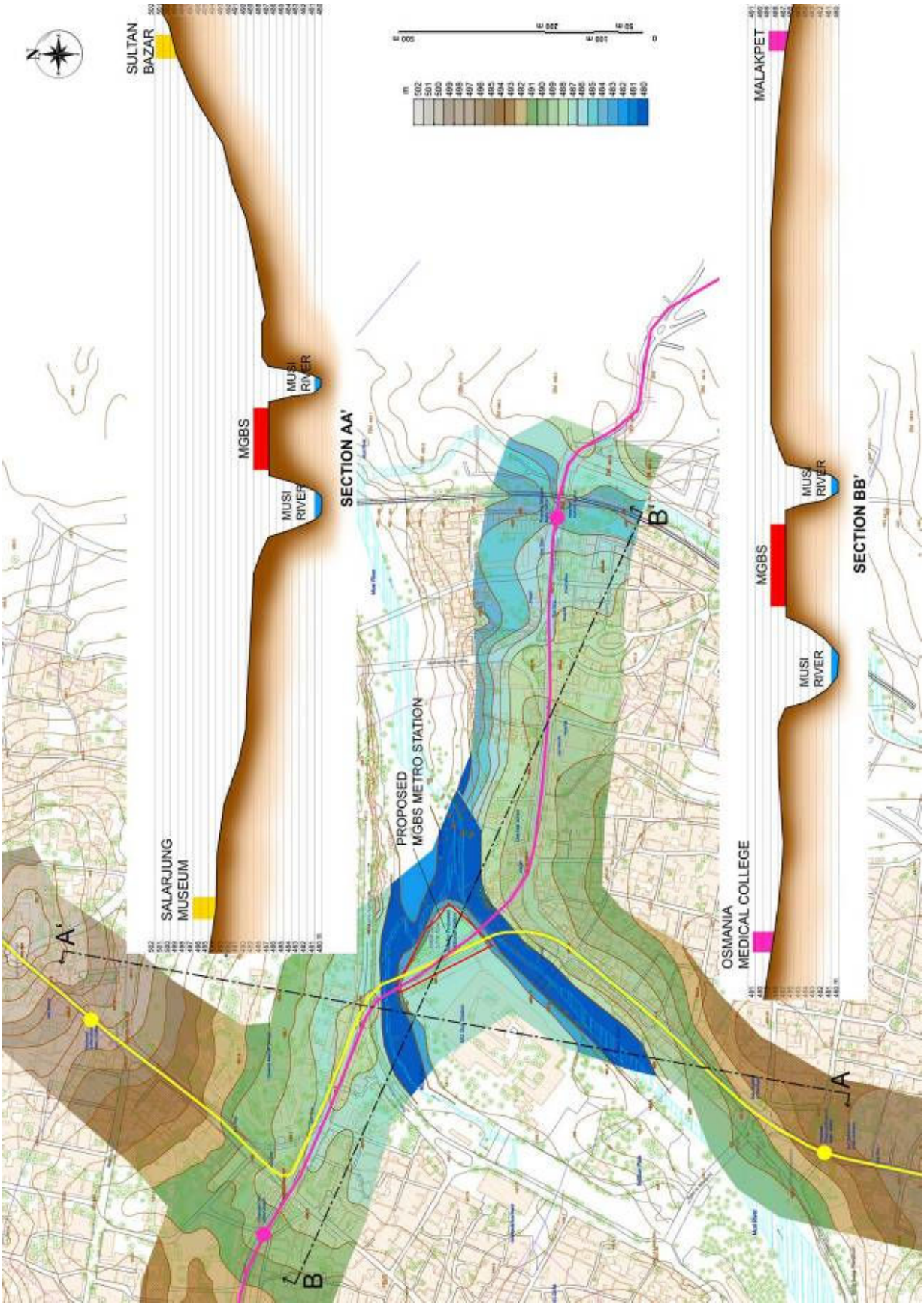
- Miyapur-LB Nagar line is passing through the heavy traffic roads at OMC and Malakpet areas. And also there are many religious places and institutions are in the area of Malakpet.

To minimize the impact on the road side buildings, heritage structures and trees because of the metro corridor construction activities, there should be careful alignment and design in these areas.

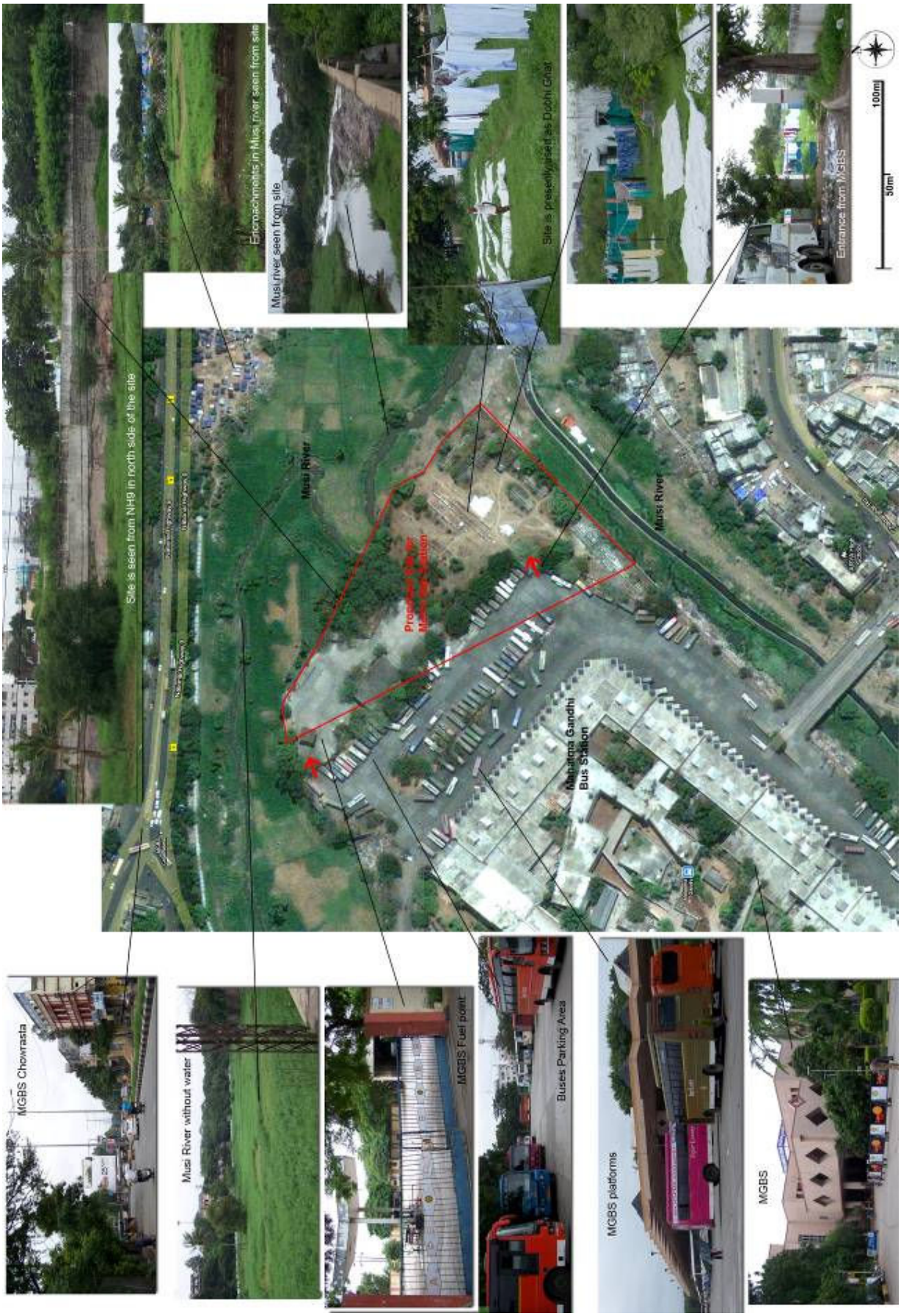

STUDY AREA
SALARJUNG MUSEUM
MALAKPET
MGBS
OMC
SULTAN BAZAR



In the study area, towards Malakpet and Salarjung museum is maximum covered with residential zone. Sultan bazaar and OMC areas are under multiple use zone and Public zones.



Contour map showing the sections of study area. The contour levels are varying from 480m to 501m. The slope is towards Musi River.



Site for proposed MGBS metro station

8.2. Site analysis

- The area allotted for proposed MGBS metro station site is 3.776 Acre. The site is 8m height from Musi river bed. The land is flat and covered with grass and few trees. Part of the site is used for APSRTC bus shed and petrol pump. Another part is used as dhobi ghat. It is having well connectivity to the MGBS bus station.
- Sultanbazar area is having very narrow road of only 10m and busy with road shopping. As per the master plan the proposal of widening to 30m by demolishing business complexes and old houses. The people in this area are opposing this proposal as it spoils their livelihood.
- Infront of OMC there are many bus stops, small shops and hawkers. The metro construction may have impact on them.
- Salarjung museum area is surrounded with many heritage structures, religious structures, landmarks and old constructions having heritage value.
- Malakpet area roads are narrow and with heavy traffic daily. And also there are many religious places and institutions are in this area.
- There are 154 buildings to be demolished in the study area in road widening for the construction of metro corridor according to the HMR proposal.
- There are 164 trees to be cut in the study area according to the HMR metro corridor proposal.
- There are possibilities of contamination of Musi River as the pillars will be constructed in the river.

9 REDUCING IMPACT
SULTAN BAZAAR TO OMC

9.1. Reducing Negative impact

Sultan bazar area is most effecting in road widening in the study area. This place is very famous as Koti for road shopping. If all the hawkers are displaced, they will loose their livelihood and also the place will loose its importance. As the road is very congested having width of only 10m, the heavy vehicles are not allowed. Even after road widening heavy vehicles should not be permitted.

9.1.1. 20m Road at Sultan Bazar

As per the HMR and MCH the proposed road widening is 30m. In this case people loose their property on both sides of the road in major. As the road is not meant for heavy vehicles, the road can be widened only for 20m to reduce the impact on the buildings.

9.1.2. Saving Religious, Heritage and Landmark Structures

There is a huge and very old Jain Mandir in the Sultan bazar area. There are three old buildings with heritage value adjacent to Jain Mandir. Andhrabank is the Landmark building at Koti Junction. All these structures can be retained with changing in road widening and direction.

9.1.3. Minimum Displacement of People

When we observe closely people are loosing only the part of their properties. So the permission for additional floor can be given as the compensation. The road can be developed with walkways, bicycle way, two wheeler way and landscape. The center space under the metro line can be utilized for two wheeler parking.

9.1.4. Place for Hawkers

Space can provided for the hawkers, so the displacement of the hawkers can be avoided. And also significance of Koti as the road shopping area can be retained.

9.1.5. Saving trees

In this area there are 17 trees have to be cut down in road widening as per HMR proposal. Only 4 trees are coming in metro line and in the road space after the design. So 13 trees can be retained with careful road widening and footpath design.

9.1.6. Minimum impact on Utilities / Amenities

Bus shelters in front of Osmania medical college are coming in the line of Foot path after road widening. They can be re adjusted and moved 2-3 meters back at the same location after developing.

9.1.7. Better location for Sultan Bazar Metro Station

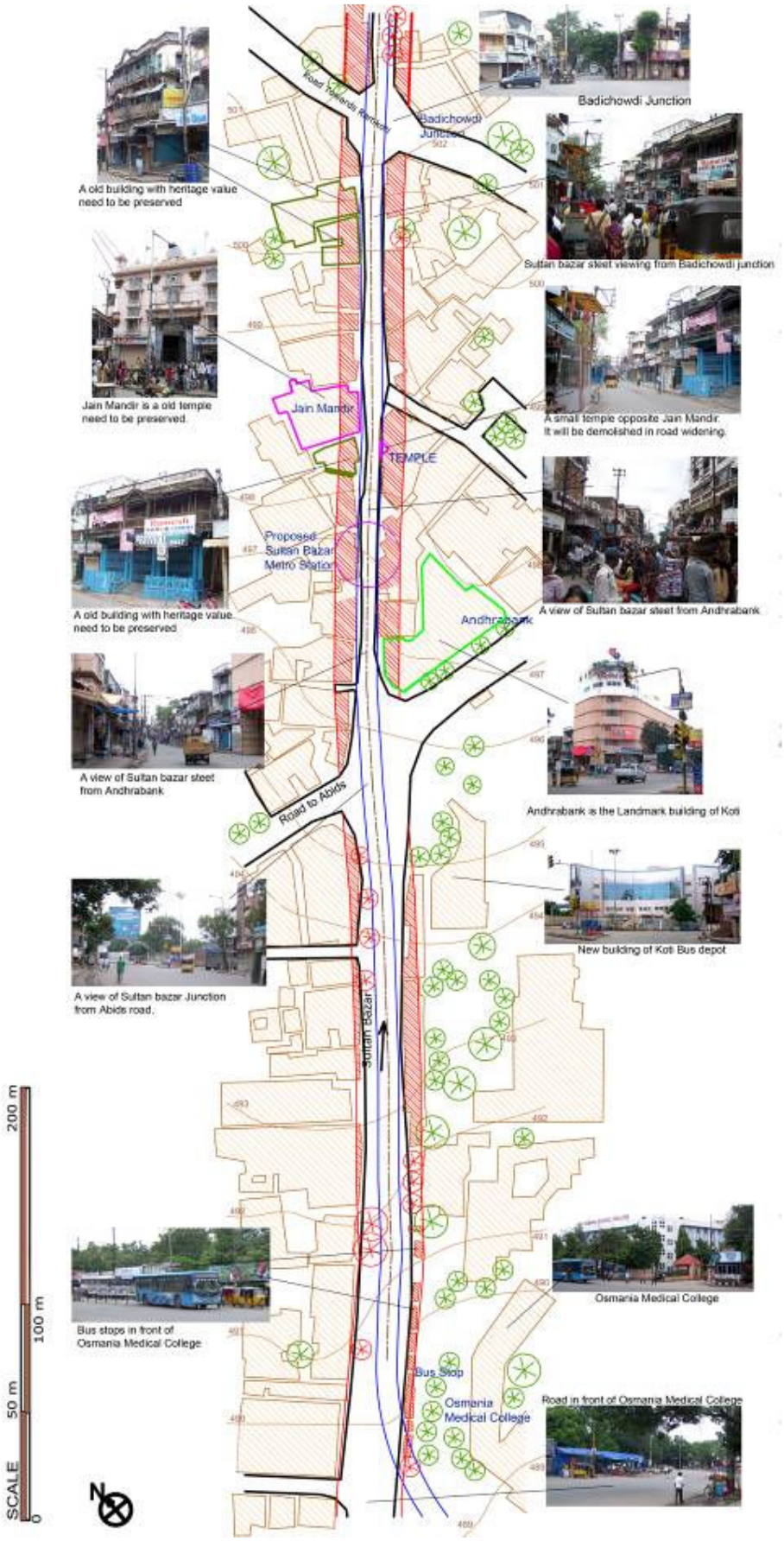
The HMR proposal for Metro station behind Andhrabank will be congested on the below road. As the road width is less it is better to shift to the location in front of Koti bus depot. There will be better connectivity to the bus depot as well as the bus stops near OMC.

9.1.8. Bicycle Rental Point near Metro Station

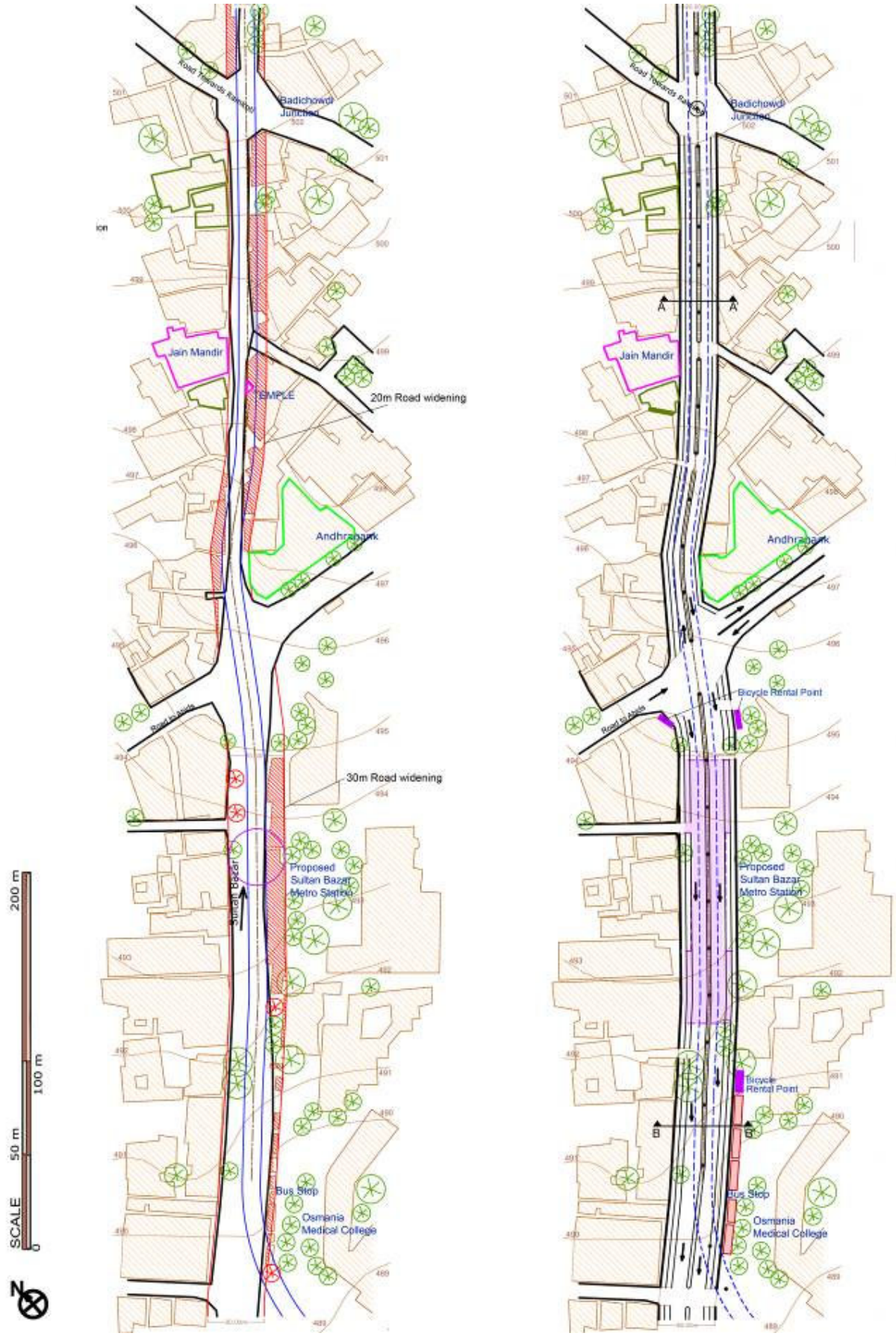
Bicycle rental points near Metro station can be installed. They can serve the people coming to Koti area for shopping and other purposes. So the vehicles volume on road can be reduced as the cost for hiring a bicycle is very less compared to other modes of transport.

	BUILDINGS		**TREES**
	TOTALLY	PARTIAL	
AFFECTING BEFORE DESIGN (HMR proposal)	2	27	17
AFFECTING AFTER DESIGN	3	10	4
SAVED	**16**		**13**

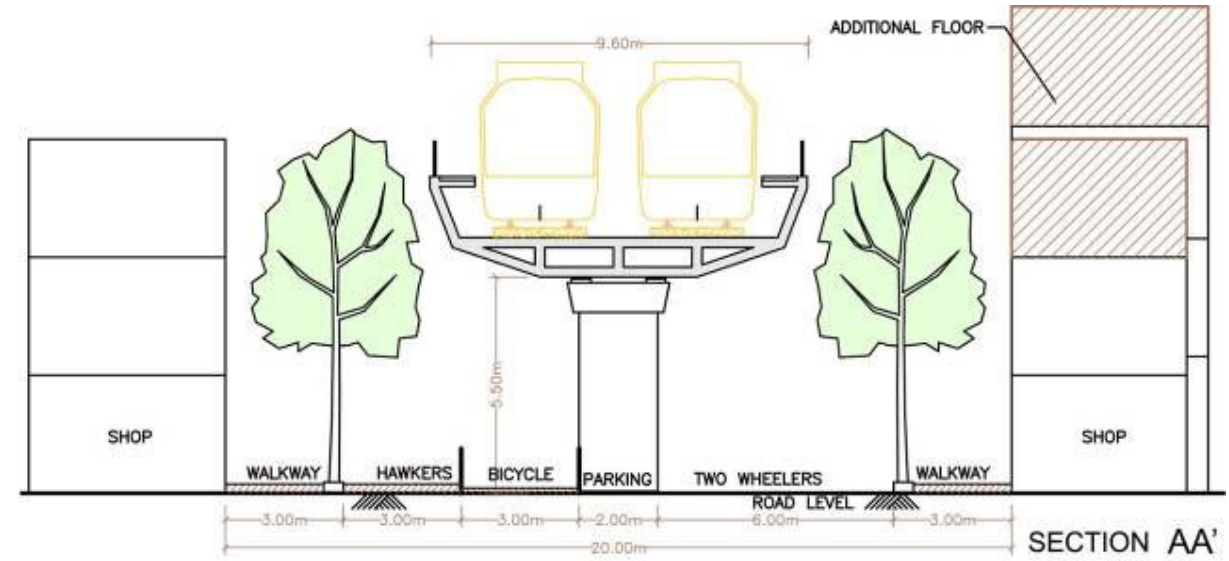
Buildings saved: Religious-1; Commercial-11; Public/Semi Public-1; Heritage-3

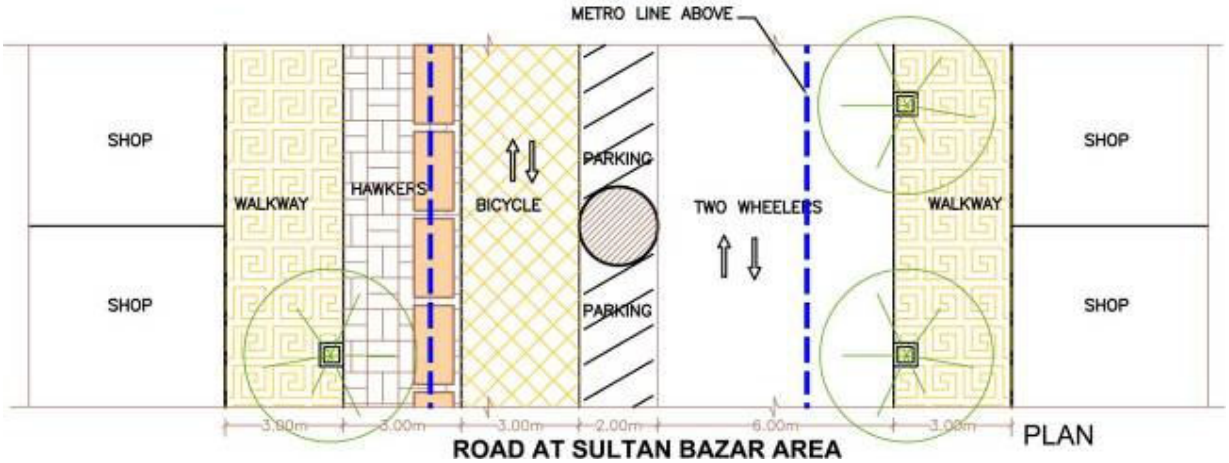


HMR proposal

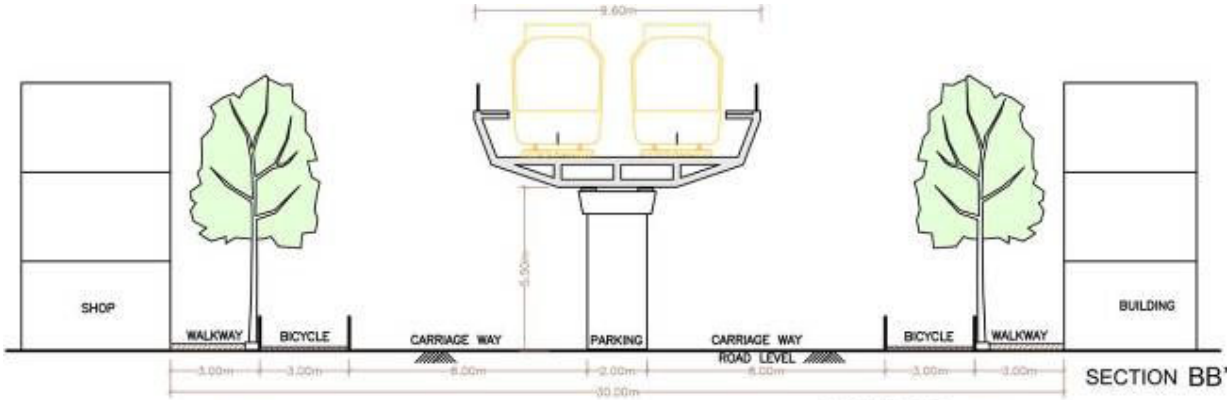


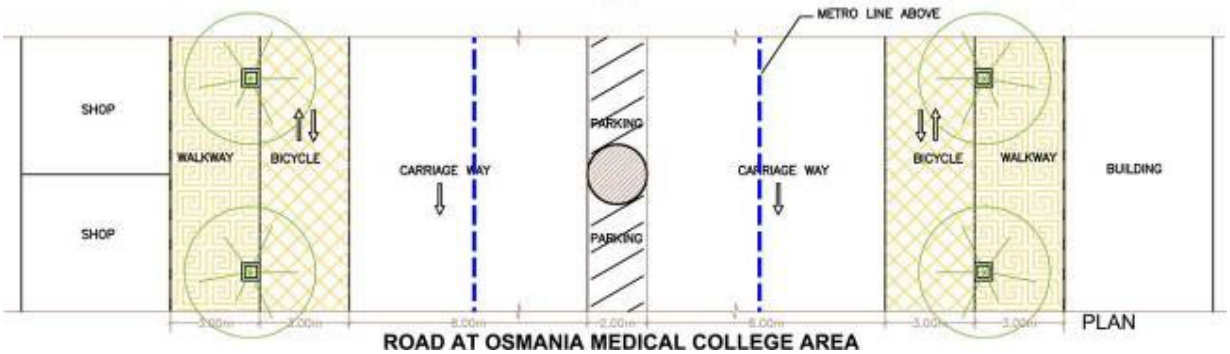
Design proposal





ROAD AT SULTAN BAZAR AREA





ROAD AT OSMANIA MEDICAL COLLEGE AREA

10 REDUCING IMPACT
OMC TO MGBS

10.1. Reducing Negative impact

10.1.1. Intersection of Metro Lines

Metro lines JBS-Falaknuma and Miyapur-LB Nagar are intersecting near Osmania Medical College before entering the MGBS. The two lines are taken at differnt heights one above another to save road space below.

10.1.2. Avoiding Short Metro curve in front of OMC

It is impossible to achieve metro line with short curve in front of OMC. At least it requires 120m curve radius as per the standards. So the land infront of OMC is used for metro line with out disturbing any structure. 20m of distance is maintained from the OMC building. To reduce the Noise pollution Sound absorbers are installed on the tracks.

10.1.3. Minimum Displacement of People

When we observe closely people are loosing only the part of their properties. Out of 23 affecting buildings 8 buildings can be retained. So the permission for additional floor can be given as the compensation for damaged buildings.

10.1.4. Saving trees

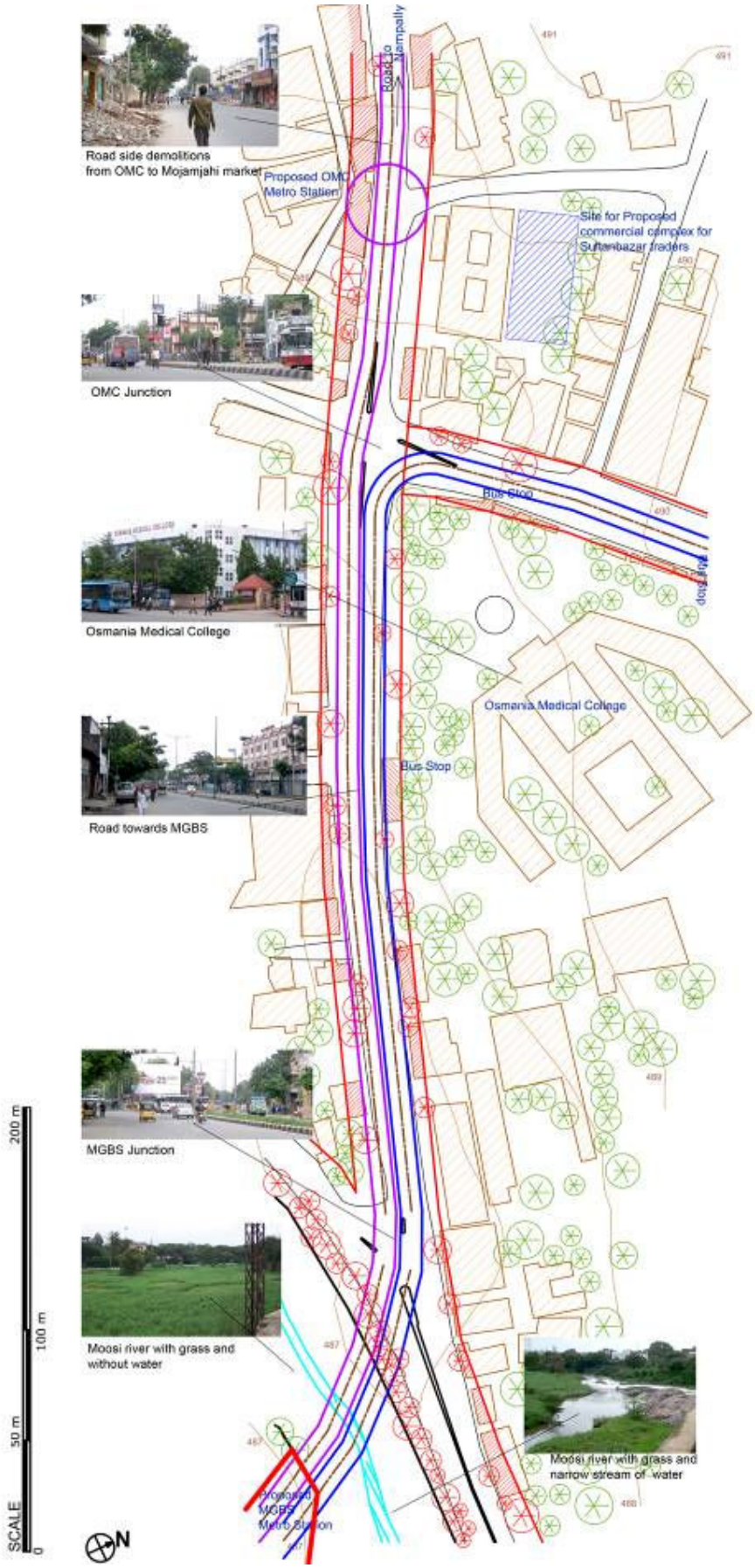
In this area there are 59 trees are cut down in road widening as per HMR proposal. Only 27 trees are coming in metro line and in the road space after the design. So 32 trees can be retained with careful road widening and footpath design.

10.1.5. Minimum impact on Utilities / Amenities

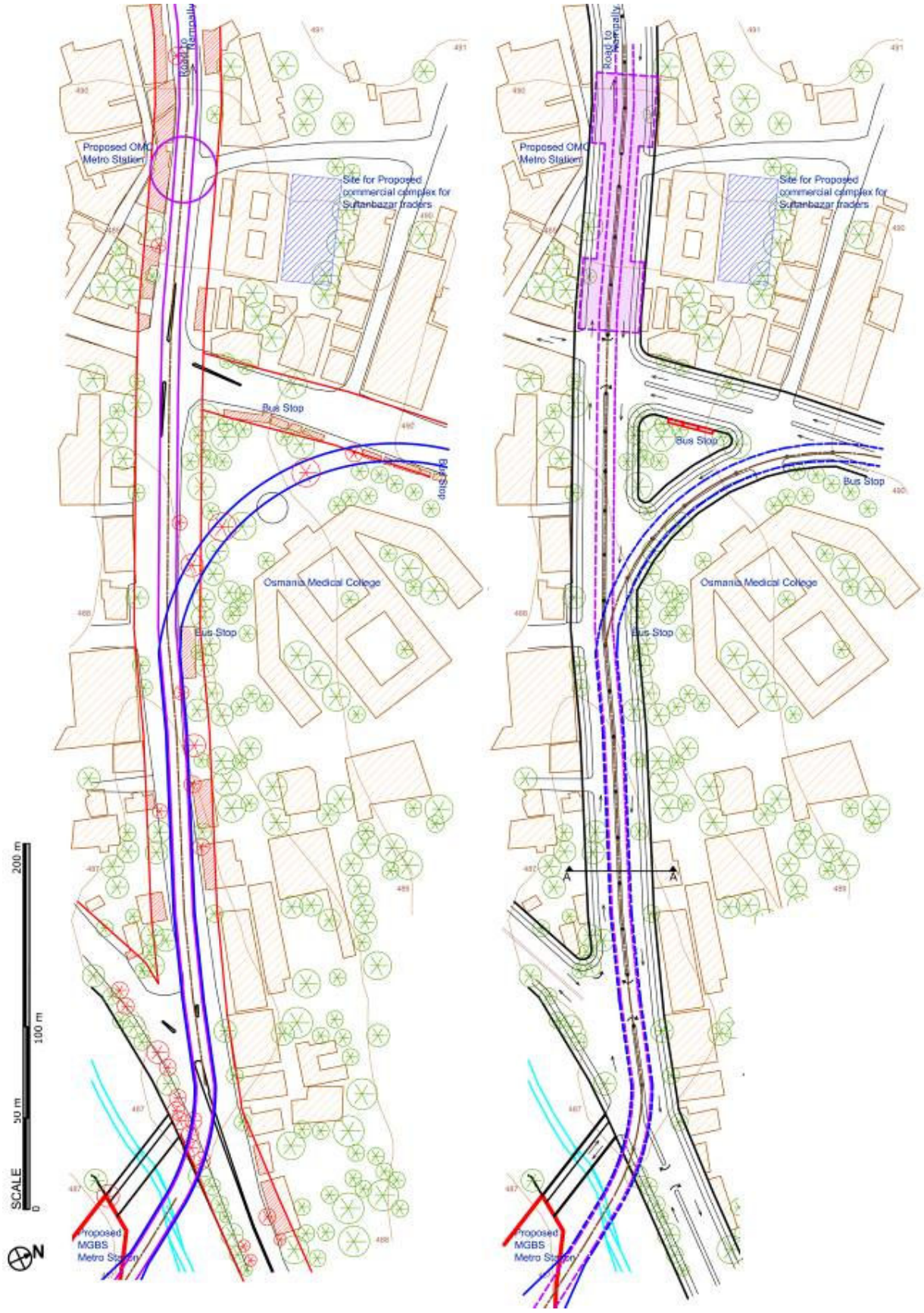
Bus shelters in front of Osmania medical college are coming in the line of Foot path after road widening. They can be re adjusted and moved 2-3 meters back at the same location after developing.

10.1.6. Bicycle Rental Points near Metro Station

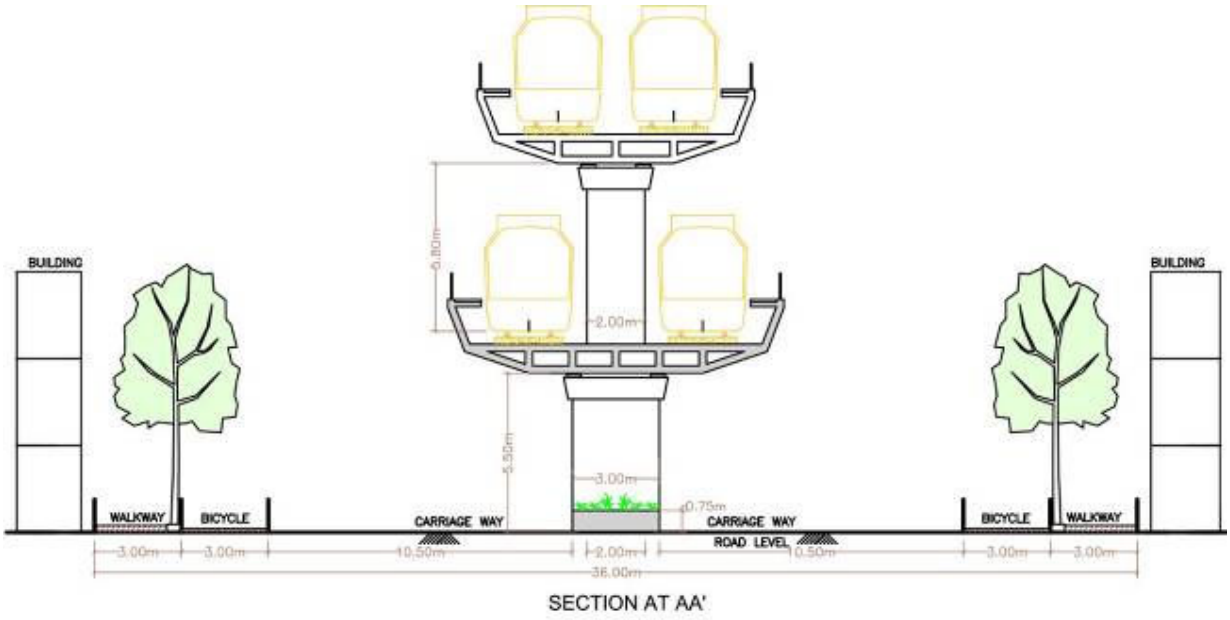
Bicycle rental points near Metro station can be installed. They can serve the people coming to Koti area for shopping and other purposes. So the vehicles volume on road can be reduced as the cost for hiring a bicycle is very less compared to other modes of transport.



HMR proposal



Design proposal



SECTION AT AA'

Road section at Metro lines intersection with tracks one above other

PLAN

36M WIDE ROAD

	BUILDINGS		**TREES**
	TOTALLY	PARTIAL	
AFFECTING BEFORE DESIGN (HMR proposal)	0	23	59
AFFECTING AFTER DESIGN	0	13	27
SAVED	**10**		**32**

Buildings saved: Commercial- 10

11 REDUCING IMPACT
MGBS TO SALARJUNG MUSEUM

11.1. Reducing Negative impact

11.1.1. Saving Religious and Heritage Structures

There are five Masjids in this area. There is Quli Qutubshah Urban authority old building with heritage value in this area. All these structures can be retained with changing in metro alignment.

11.1.2. Reducing number of demolishing Buildings

There are totally 53 buildings are totally and partially affecting in road widening. 18 buildings can be saved by re-aligning the metro line. So the permission for additional floor can be given as the compensation for demolished buildings.

11.1.3. Saving trees

In this area there are 54 trees have to be cut down in road widening as per HMR proposal. Only 23 trees are coming in metro line and in the road space after the design. So 31 trees can be retained with careful road widening and footpath design.

11.1.4. Minimum impact on Utilities / Amenities

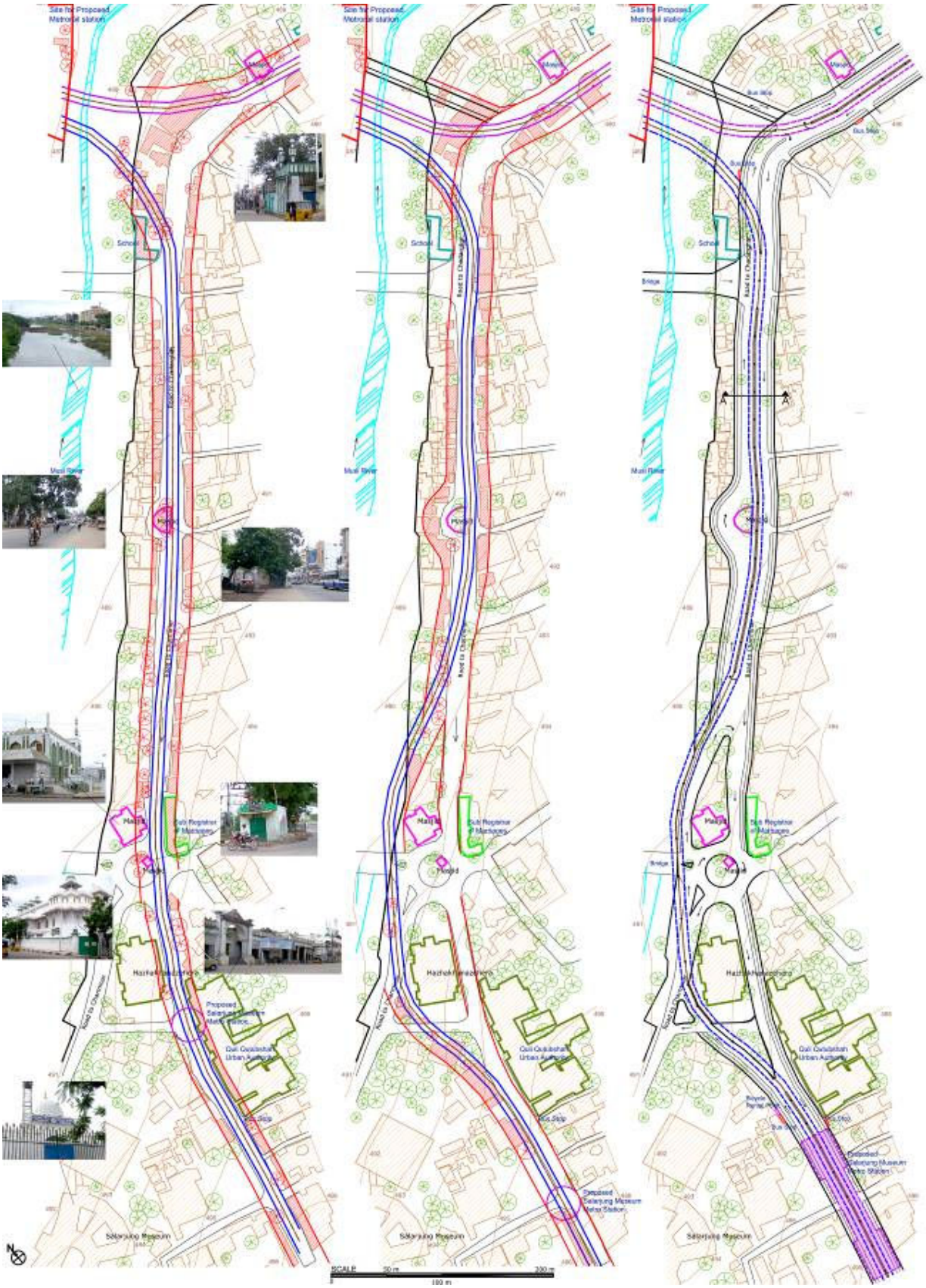
Bus shelter in front of Quli Qutubshah Urban authority old building is coming in the line of Foot path after road widening. They can be re adjusted and moved 2-3 meters back at the same location after developing.

11.1.5. Better location for Salarjung Museum Metro Station

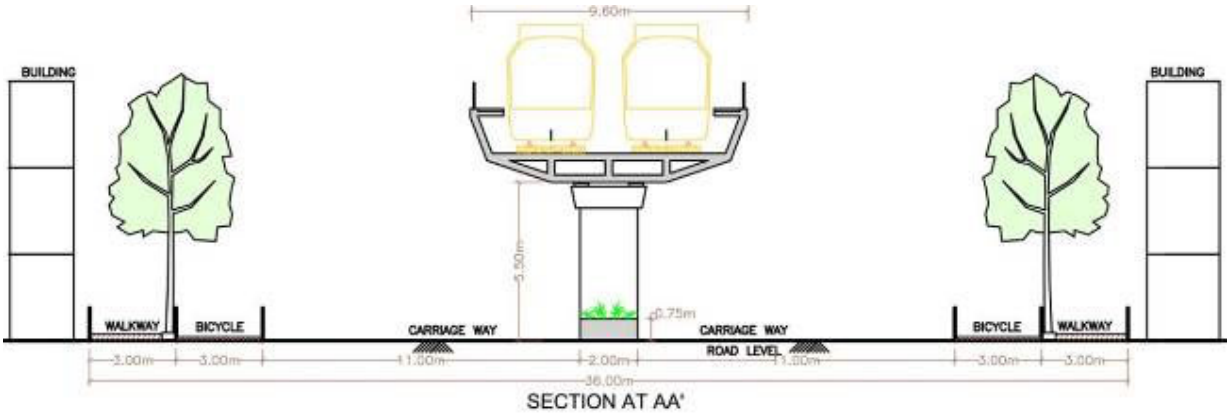
The HMR proposal for Metro station infront of Quli Qutubshah Urban authority old building will be congested on the road. As the road width is less it is better to shift to the side of the building also to reduce impact on the old building.

11.1.6. Bicycle Rental Points near Metro Station

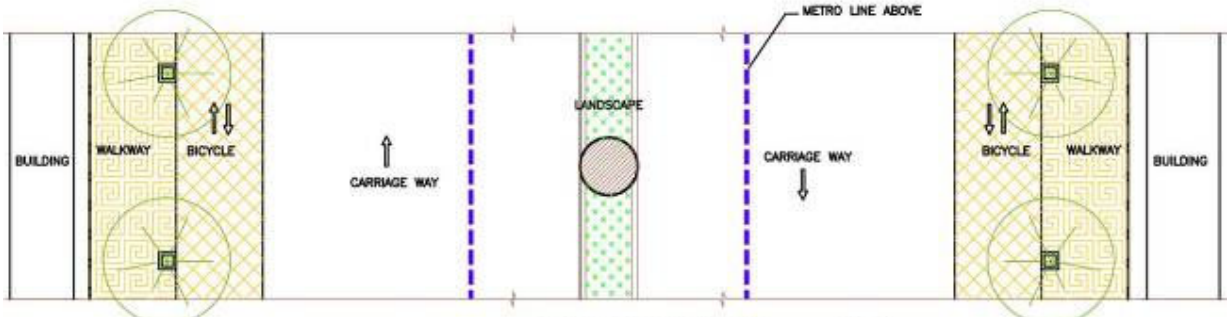
Bicycle rental points near Metro station can be installed. They can serve the people coming to this area for Salarjung Museum and other purposes. So the vehicles volume on road can be reduced as the cost for hiring a bicycle is very less compared to other modes of transport.



(Left) HMR proposal; (Right) Design proposal



SECTION AT AA'



36M WIDE ROAD PLAN

	BUILDINGS		TREES
	TOTALLY	PARTIAL	
AFFECTING BEFORE DESIGN (HMR proposal)	53	22	54
AFFECTING AFTER DESIGN	27	26	23
SAVED	**22**		**31**

Buildings saved: Residential-10; Religious-5; Commercial-4; School/College-1; Public/Semi Public-1; Heritage-1

12 REDUCING IMPACT
MGBS TO MALAKPET

12.1. Reducing Negative impact

MGBS to Malakpet road is very busy and most of the time with traffic jams. It is a narrow road with lot of traffic from Dilsukh nagar and chadarghat causing traffic jams. There is very narrow road space under the railway track of Malakpet railway station causing vehicles to move very slowly. This road is widened to 36m.

12.1.1. Saving Religious Structures

There is a Jain Mandir and Masjid in this area. All these structures can be retained with changing in road widening and direction.

12.1.2. Minimum Displacement of People

When we observe closely people are loosing only the part of their properties. So the permission for additional floor can be given as the compensation. With change in the metro line alignment the displacement of people can be reduced.

12.1.3. Saving trees

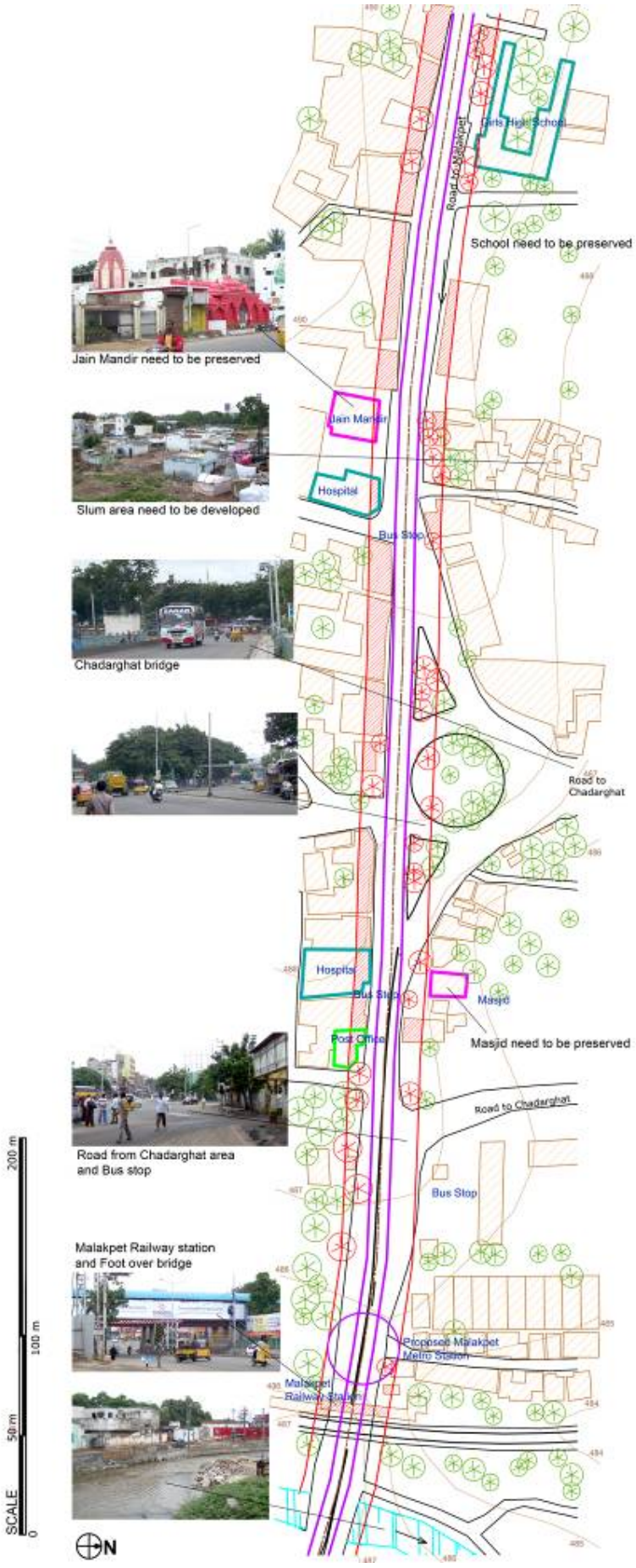
In this area there are 34 trees have to be cut down in road widening as per HMR proposal. Only 16 trees are coming in metro line and in the road space after the design. So 18 trees can be retained with careful road widening and footpath design.

12.1.4. Minimum impact on Utilities / Amenities

Bus shelters near Jain mandir and Chadarghat road are coming in the line of Foot path after road widening. They can be re adjusted and moved 2-3 meters back at the same location after developing.

12.1.5. Bicycle Rental Point near Metro Station

Bicycle rental points near Metro station can be installed. So the vehicles volume on road can be reduced as the cost for hiring a bicycle is very less compared to other modes of transport.



HMR proposal

Design proposal

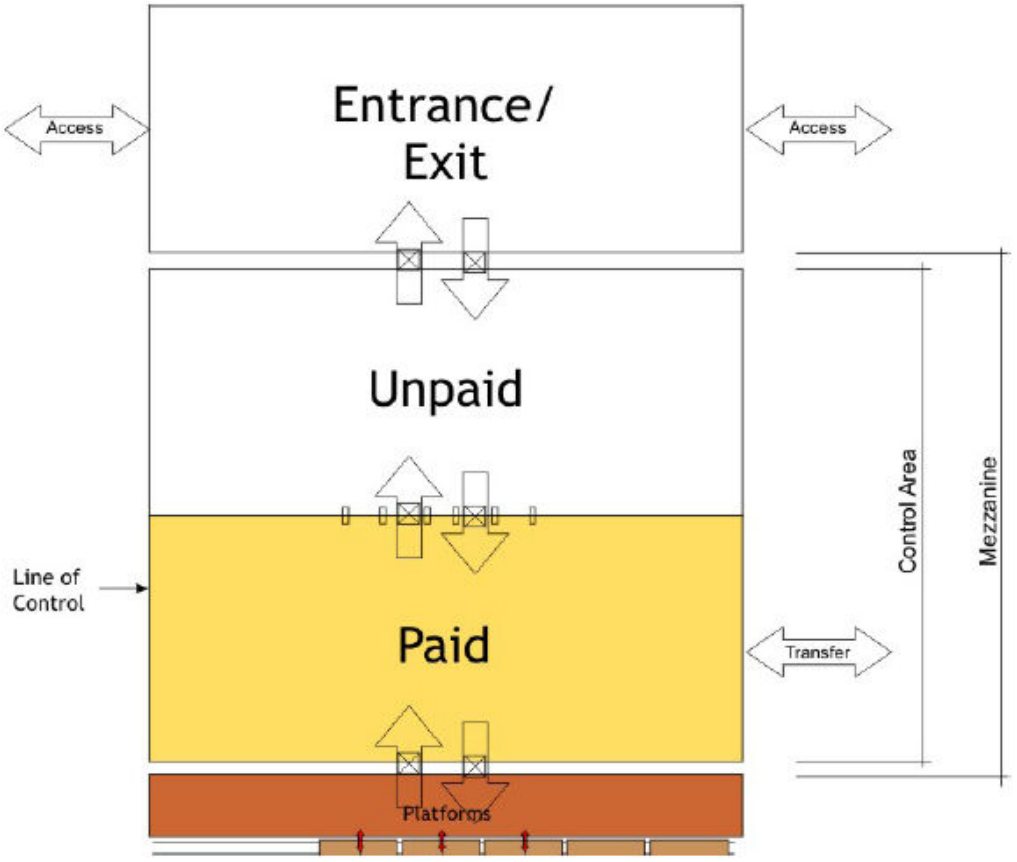
	BUILDINGS		TREES
	TOTALLY	PARTIAL	
AFFECTING BEFORE DESIGN (HMR proposal)	3	24	34
AFFECTING AFTER DESIGN	3	18	16
SAVED	**6**		**18**

Buildings saved: Religious-2; Commercial-2; School/College-1; Hospitals-1

13 METRO STATION DESIGN

13.1. Station Planning and Design

- The Station shall be visually appealing; open, spacious, well lit and consistent with the environment. The Station planning shall permit maximum cross ventilation and natural light for the Station as well as for the roadway below the Station.
- Facilities shall be provided for handicapped persons.



Typical station components

13.2. Station Design Requirements

Stations shall be designed for peak flow of User traffic and the requirements of future Train Services and shall follow NFPA 130 (National Fire Protection Association). The following elements are to be designed and provided for:

(i) Adequate ventilation and lighting for the road users below;

(ii) Ticket counters/Automatic ticket vending machines should be provided before access to Security check and platforms.

(iii) User amenities to help in decentralizing customer volume and to facilitate easy maintenance;

(iv) Space for passenger operated machines (Automatic Ticket Dispensing Machines) for future;

(v) Passenger kiosks and commercial kiosks;

(vi) Customer service center;

(vii) Emergency evacuation exits

(viii) AFC (Automatic Fare Collection) system and AFC gates;

(ix) Parking and circulation area for traffic integration;

(x) Station entrances and exits to allow for entry/exit of Users under normal and emergency conditions, with doors opening both ways;

(xi) Escalators, lifts and stairs;

(xii) On line Passenger Information System including digital clocks and PA system;

(xiii) Signage, name boards and route maps;

(xiv) Requirements for physically challenged Users and senior citizens;

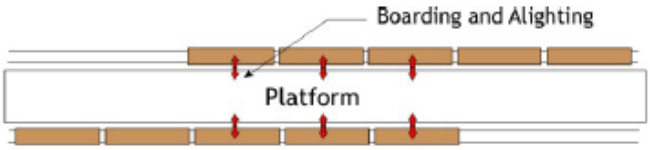
(xv) Landscaping works;

(xvi) Security alarm and fire protection system to be located in Station manager's room complete with fire fighting equipment as per requirement of concerned authorities; and

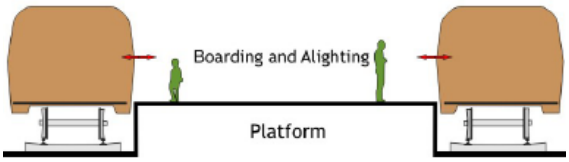
(xvii) Lightning protection and primary surge protection system for incoming power supply to the building and for sensitive relays and electronic equipment.

13.3. Center Platforms

Center platforms are preferred in most cases. Center platforms are located between tracks; passengers board and alight from either side of the platform. In determining emergency egress capacity any platform that can serve as noted above will assume 2 trains discharging simultaneously.



Center platform Plan



Section

13.3.1. Advantages of center platforms include:

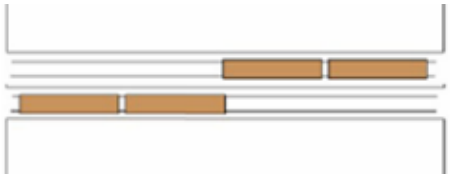
1. Deferred directional decision-making, which simplifies wayfinding, free flow of customers, and cross-platform transfers.
2. More efficient use of space and VCEs, since customers traveling in both directions can share platform space and VCEs.
3. Platform width that may be less than combined width of equivalent side platforms; the resulting station may be smaller and less expensive.
4. Spacing between tracks can be wider to accommodate crossovers.
5. Fewer elevators to the platform level are required to provide equivalent accessibility.
6. Possible reduction in the need to cross oncoming traffic (in order to reach vertical circulation) when a single concourse is provided.
7. Ability of passengers to change train directions without crossing tracks and changing levels.

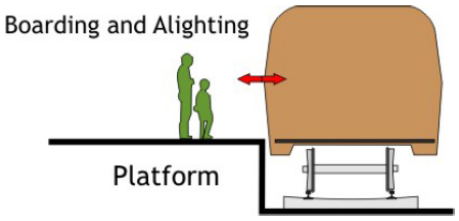
13.3.2. Disadvantages of center platforms include:

1. Queuing for vertical circulation must mix with queuing for vehicle boarding along the platform.
2. Limited options for elevator placement (than for side platform stations) since elevators must be placed in the center of the platform width.
3. Less accessible wall area available for signage, advertising, and art.
4. Limited flexibility for future expansion (future connections, capacity, space, VCEs).
5. Less ability to accommodate increased vertical circulation demands and surges in reverse commuters.

13.4. Side Platforms

Side platforms provide access to trains along one side of the track. The passenger must decide between platforms based on their direction of travel prior to descending to platform level.





Side platform Plan Section

13.4.1. Advantages of side platforms include:

1. Increased flexibility in locating emergency egress and VCEs
2. Ability to accommodate high-volume, bidirectional customer flows while avoiding bidirectional conflicts
3. Potentially greater capacity for vertical circulation and emergency egress, since it is generally possible to provide more vertical circulation devices
4. Better accommodation of long-term ridership changes (such as increases in the number of reverse commuters)
5. Better accommodation of queuing at VCEs, due to reduced conflict with queuing at platform edge
6. Greater flexibility for future expansion
7. More wall area available for signage, advertising, and art; easier wall access

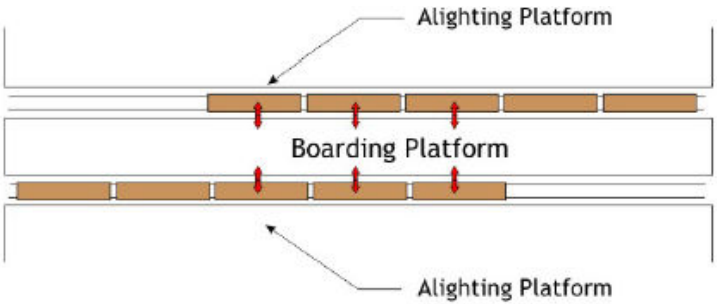
13.4.2. Disadvantages of side platforms include:

1. Need for directional decisions to be made prior to descending to the platform, in order to avoid backtracking and delay
2. Need for clear signage to be provided so that customers can select the appropriate platform
3. Need for passengers to change levels and cross tracks to change train directions
4. Less space efficiency, resulting in wider stations (minimally sized platforms meeting requirements under NFPA 130 will be larger than a single minimally sized center platform)
5. Greater number of VCEs for equivalent capacity

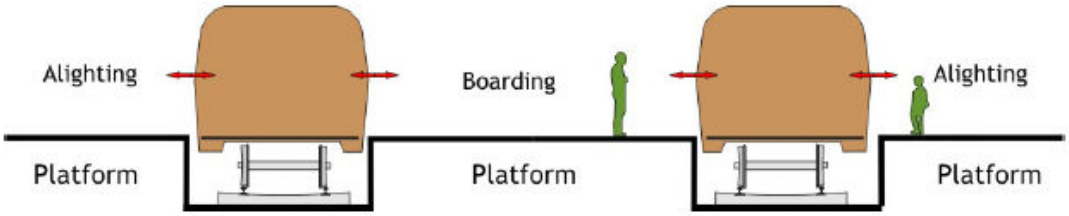
13.5. Flow-Through Platforms

Flow-through platforms allow passengers to board and alight the train from dedicated platforms, thereby eliminating conflicting passenger flows. Flow-through platforms speed boarding and alighting and therefore reduce vehicle dwell time at the platform. Flow-through platforms are not typically used due to cost and operational considerations, but they may have applications where very

high passenger volumes and/or unique passenger characteristics (e.g., a high percentage of passengers with bags) require that the station designer minimize cross-flows on the platform and dwell times.



Plan



Flow-through platform Section

13.5.1. Advantages of flow-through platforms include:

1. Unidirectional customer flow, which eliminates conflicts between boarding and alighting customers.
2. Facilitation of movement of customers with baggage
3. Greater capacity for vertical circulation and emergency egress

13.5.2. Disadvantages of flow-through platforms include:

1. Less efficient use of VCEs
2. Operational complexities

13.6. Configuration

METRO station platforms shall be either center or side platform type. Center platforms are preferred when in the street median; side platforms are preferred for off-street stations or when site constraints prohibit the use of center platforms.

The platform minimum area (excluding vertical circulation elements, structures, furnishings, surge zones, and the platform detectable warning pavers strip) should accommodate the peak 15-minute entraining and detraining loads at 7 square feet per person. Peak hour design headways shall be factored into area calculations.

13.6.1. Platform Length (Calculated Platform): The standard "calculated platform length" available for boarding and alighting is 280 feet. The absolute minimum platform boarding length is 260 feet and requires METRO approval.

13.6.2. Platform Width: 16 feet-4 inches is the minimum design width for METRO station center platforms. The desirable station platform at terminal stations and high patronage stations is **18 feet wide** including a 24 inches wide detectable warning strip. For side platforms at-grade, the standard width is **14 feet** (12 feet minimum) from the edge of platform to the face of station wall or barrier railing, including a 24 inches wide detectable warning at the platform boarding area.

13.6.3. Rolling Stock: The User capacity of Coach for all normal and degraded performance requirements shall be based on all seats full, with standing capacity in the free standing space of:
(i) 4 persons per square meter for normal load;

(ii) 6 persons per square meter for maximum load; and

(iii) 8 persons per square meter for crush load.

13.6.4. Dynamic Profile:

The width of Coach shall not exceed **3.2 m.**

The height of Coach, from rail level, shall not exceed **4.0 m.**

Each Coach shall have minimum of 8 electrically powered, exterior sliding bi parting doors**, 4 on each body side**, conforming to EN 14752. The free passing through **height of open doors shall be 1900 mm minimum. The minimum door width shall be 1400 mm.** The number and width of doors shall enable short stopping dwell times.
Nominal clear height inside the Coach shall be **2100 mm.**
Width of seats shall be 450 mm.

13.6.5. Track Gauge: Track shall be laid to **standard gauge of 1435 mm**, the track gauge being the distance between the inner sides of the head of rails measured 14 mm below top of rails.

13.6.6. Grades shall not exceed the following limits:

(i) Station – maximum – 0.1%

(ii) Midsection – normal – 2%

(iii) Midsection – exceptional – 4% Grades shall be kept as flat as possible.

13.6.7. Static Car Profile: It is the profile of the maximum cross sectional dimension of the car at rest on straight and level track. This profile should provide for tolerances in manufacture and effect of load on the suspension. This is the basic profile on which other profiles are built, and depends on the car supplier. A maximum limit of 3.2 m width and 4.0 m height has been fixed within which the static car profile has to be accommodated.

13.7. Clearances

The actual clearance required between Coaches and structures is influenced by Train speed, track irregularity, and maintenance condition of Coaches. The kinematic and structure gauge depend on the Coach design, particularly the Coach width, Coach Height, Coach Length, and distance between Bogie centers. Absolute values for the clearances are to be finalized by the Concessionaire, in consultation with the IE. Only broad guidelines, and typical values for a **Coach of width 2900 mm, length 21940 mm** and Bogie centers of 14850 mm are furnished in this Appendix I.

The Concessionaire shall submit a comprehensive Schedule of Dimensions covering all aspects in consultation with the IE.

13.7.1. Platforms

(i) Maximum horizontal distance from center of track to face of platform coping: 1515mm
(ii) Minimum horizontal distance from center of track to face of platform coping: 1500mm
Height above rail level for passenger platform coping

Standard height of platform may be maintained at 1100 mm with a tolerance of +5 mm, -0 mm.

Horizontal distance to any structure on platform: Since track in stations shall not have cant, allowance for lean due to cant has not been provided:

(a) Minimum horizontal distance of any 2500 mm isolated structure (length 2000 mm or less) on a passenger platform from edge of coping
(b) Minimum horizontal distance of any 3000 mm continuous structure on a passenger platform from edge of coping

13.7.2. Traction Power System: Traction supplies shall be distributed at 750V DC or as per design voltage in accordance with IEC 60850, Railway Applications – Supply Voltages of Traction Systems. 750V DC Stringer type of current collection systems shall be provided in Depot.

13.7.3. Minimum carriageway width: Minimum carriageway width on the roadway at ground level during the entire period of construction shall be maintained as 8.75 m in each direction, except for stretches where existing ROW does not allow this width to be maintained. For such portions, a comprehensive traffic management/diversion plan shall be adopted prior to construction in consultation with the Independent Engineer.

For construction/erection of the elevated guideway, maximum width of barricaded zone at the existing central median shall be limited to 8.0 m.

13.7.4. Vertical Clearance below deck: The minimum vertical clearance available below soffit of guide way structure shall be **5.50 m** and / or as per relevant IRC codes. Minimum vertical clearance above existing rail track shall be as per schedule of dimensions of Indian Railways, but not less than **5.80 m.**

13.7.5. Passage for Emergency Evacuation of Users: A passage of width not less than 700 mm with safety railing shall be provided on each side of the double track all along the elevated corridor to facilitate evacuation of Users during Emergency.

13.8. Elevated Guide way Structure – Design Criteria

The overall width of the guide way structure shall be maximum 9.6 m with track centre at 3.7 m - 4.0 m. The minimum clearance above the road level shall be 5.5 m. In case of minor roads/streets a lower clearance may be adopted with specific approval of the agency or authority owning and / or maintaining the road/street. The vertical clearance above the rail level where the alignment crosses the existing railway track shall be in accordance with the Schedule of Dimensions of Indian Railways but in no event less than 5.8 m. A passage of adequate width (not less than 700 mm) on both sides of the guide way all along the corridor shall be provided for Emergency evacuation.

13.8.1. Minimum thickness of members: Desirable minimum thickness of any concrete member

Deck – 200 mm
Web of T-beam – 250 mm
Web of pre-stressed girders – 150 mm + d
If there are 2 cables at any level – 150 mm + 3d
(Where d is the outside diameter of the cable duct)

Box Girders: minimum thickness of member:

Deck slab – 200 mm Bottom flange – 300 mm
Web – 250 mm

13.9. Station Planning and Design

Road clearance shall be 5.5m (min) at concourse level at Stations. This clearance of 5.50m shall also be available outside the Station area on road side beyond vertical plane drawn on outer face of crash barrier of elevated guide way supporting column.

13.9.1. Spatial Vertical Clearances:

(a) All public spaces including stairs and ramps shall have a minimum ceiling height or vertical clearance of 3 m.

(b) All non-public spaces including stairs and ramps shall have a minimum ceiling height or vertical clearance of 2.4 m.

Platforms shall have a clear head room of at least 3000 mm to structures and platform signs to a width of at least 2000 mm from the platform edge over their entire length. Suspended signs, fittings, and fixtures shall have a minimum clearance of 2.1 m above finished floor.

Each Station shall have a minimum of two main access/egress points remotely located from one another. There shall be sufficient exit to evacuate the Station occupant load from the Station platform within the time period prescribed as per NFPA 130 standard. The maximum travel distance to an exit from any point on the platform shall not exceed 100 m.

Elevators shall have minimum opening dimensions of 900 mm x 2100 mm and shall be rated for a minimum 1000 kg load. Elevator doors shall be heavy duty and all accessories shall be of the “anti vandal” type. An intercom system shall be provided between the Elevator and the Station Control Room (SCR) for emergency communication.

Escalators shall be used as stairways in stationary position during an Emergency for Station evacuation. All escalators shall be of a standard pattern, two lanes wide, having a minimum width of 1000 mm with a width at hip height of 1200 mm. They shall have four (4) flat treads at entry and exit and be equipped with double safety brushes on either side.

Stairs: Hand rails shall be provided at a height of about 900 mm. Step noses shall be rounded and color contrasted. Minimum width of stairs shall be 1500 mm. Minimum head room over a stair shall be 3.0 m.

Color: Colors shall aid maintaining high illumination levels, with sufficient contrasts and accents to provide visual interest and warmth and to conceal minor soiling. To provide uniform contrast ratio in

all Stations, a 100 mm wide yellow warning strip shall be placed adjacent to the 500 mm pavers at platform edge.

Escalators: All escalators shall be of the heavy-duty reversible type with a design maximum practical capacity of 90 persons per minute based on a service speed of 0.65 m/sec. The following requirements are given for general planning purposes:

• Inclination 30 degrees
• Step speed 0.65 m/s
• Step width (min) 1000 mm
• Number of flat steps at upper landing 4 (min)
• Number of flat steps at lower landing 4 (min)

13.9.2. Safety and security: The following features shall be incorporated in Station design to maximize safety and security of the metro system and its users.

(a) Stations shall be open, spacious and well lit so as to maximize visibility of people, platform, other building/structure areas, and parking areas.

(b) Hiding areas shall be minimized.

(c) Access points to parking area shall be minimized.

(d) Adequate lighting shall be provided, minimizing shadows and avoiding dark areas.

(e) Shatter guard protection shall be provided for glass windows/doors.

(f) Transparent material for door of the cabin of stair wells and elevators shall be provided.

(g) Planning shall provide for open lines of sight to as much area as possible.

(h) All passenger routes of travel shall be clearly defined, and shall be direct, well lit and with good visibility.

13.9.3. The Station design shall conform to the following standards:

(i) The Persons with Disabilities Act; (ii) National Building Code; (iii) NFPA 70-National Electrical Code; (iv) NFPA 72-National Fire Alarm Code; and
(v) NFPA 130-Standard for Fixed Guideway Transit and Passenger Rail Systems.

13.10. Services required in Metro station

FURNITURE, FIXTURES AND EQUIPMENT	Services Required				
	Power	Data	Water/ Sewer	Tele	Vent
Approach/Access Roads					
Under car scanners	●	●			
Information Displays	●	●			
Entrance (Drop Off)					
CCTV's	●	●			
Recycling & Trash Receptacles					
Unpaid Area					
Tourist Information Centre	●	●		●	
Station Information Centre	●	●			
Currency Exchange	●	●		●	●
GPS Clocks	●	●			
Water fountains (outlets)	●		●		
Recycling & Trash Receptacles					
Train Information Displays	●	●			
CCTV's	●	●			
Walk-in Scanning Machine	●	●			
Baggage Scanning Machine	●	●			
Control gates (selected)	●	●			
Telephone Booths	●			●	●
Electronic Ticketing Displays	●	●			
PA/CIS	●	●		●	
TVM's	●	●			
Paid Area					
Station Information Centre	●	●			
Seating in the waiting area					
Seating in the Lounges					
Tables, shelves in the Lounges					
Book/magazine racks in the Lounges					
Food/drink vending machines	●	●			●
Recycling & Trash Receptacles					
Train Information Displays	●	●			
Water fountains (outlets)	●		●		
GPS Clocks	●	●			

FURNITURE, FIXTURES AND EQUIPMENT	Services Required				
	Power	Data	Water/ Sewer	Tele	Vent
CCTV's	●	●			
PA/CIS	●	●			
Telephone Booths	●			●	●
Help-Point Intercoms	●	●		●	
ATMs	●	●			
Mobile/Laptops Charging Points	●				
Concessions	●	●	●	●	●
Track and platform displays	●	●			
Platforms					
Benches/Seats					
CCTV's	●	●			
Recycling & Trash Receptacles					
Help-Point Intercoms	●	●		●	
GPS Clocks	●	●			
Water fountains (outlets)	●		●		
PA/CIS	●	●			
Telephone Booths	●			●	●
Chemist Booth	●	●	●	●	●

Remarks: - Energy charges for non-operational (Concession) activities should be made separately from operational activities of station.

13.11. Metro interchange

An interchange zone is junction to the public transport network, in that it represents the interface between the public transport services and the surrounding area. It is a provision of special spatial arrangements, which are made for the interchanging the passengers from one mode to another.

13.11.1. Concept of interchange

Two significant components of an integrated transport strategy:

- Interchange
- Seamless travel

An interchange also often provides a convenient point from which services can be controlled. Interchange stations must not only be constructed as per design standards with adequate capacity, but also suitably located with all facilities and services.

Interchange Stations where two corridors intersect, a joint Station shall be provided with the following features:

(i) Lower level platform;

(ii) Upper level platform;

(iii) Mezzanine in between to facilitate the interchange of Users between upper and lower platforms; and

(Alternative design enabling interchange at equal or more efficiency may also be adopted)

(iv) Ticket vending facilities.

14 METRO STATION DESIGN
PROTO TYPE STATION

14.1. Prototype Metro Station Design

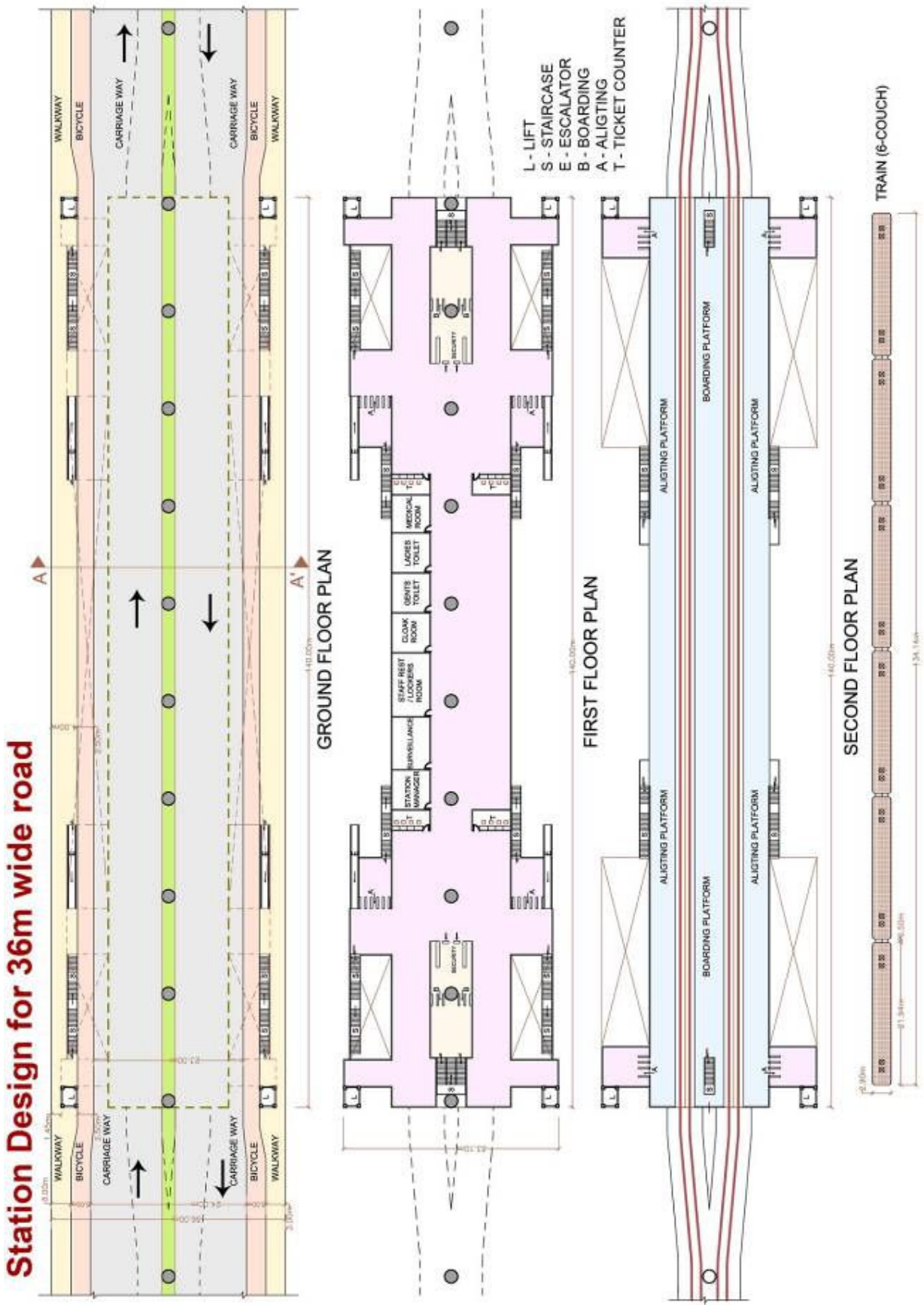
- The proto type Metro station is designed to suit the requirements for the 36m and 30m wide roads.
- It is designed to understand the function of the station, track alignment, clearances and height over the road, light and ventilation for the road below the station and accessibility, etc.
- Station is designed to support on central columns, which will be erected on median of the road.
- The vertical circulation and accessibility to the station is through Staircases, lifts and escalators. These are provided on both sides of the road.
- At road level only Staircases, lifts and escalators are provided. These are accessible from walkways on both sides of the road.
- The parking areas for the vehicles have to be suitably placed and designed as per the location of the individual stations.
- The first floor level is worked as the concourse level. Ticket counters, Security checks, automatic fare collection machines and other management spaces are provided at this level.
- The second floor level is only the platforms level. It is designed as per the flow-through platforms concept to speed up the boarding and alighting of the passengers. The central platform is meant for boarding, and the side platforms are meant for alighting.
- The Access and security check points are arranged on both sides to speed up the circulation of the people.
- The roof of the station is designed to provide sufficient light and ventilation at the platform level. Large openings are provided at all levels to have better access of light and ventilation.

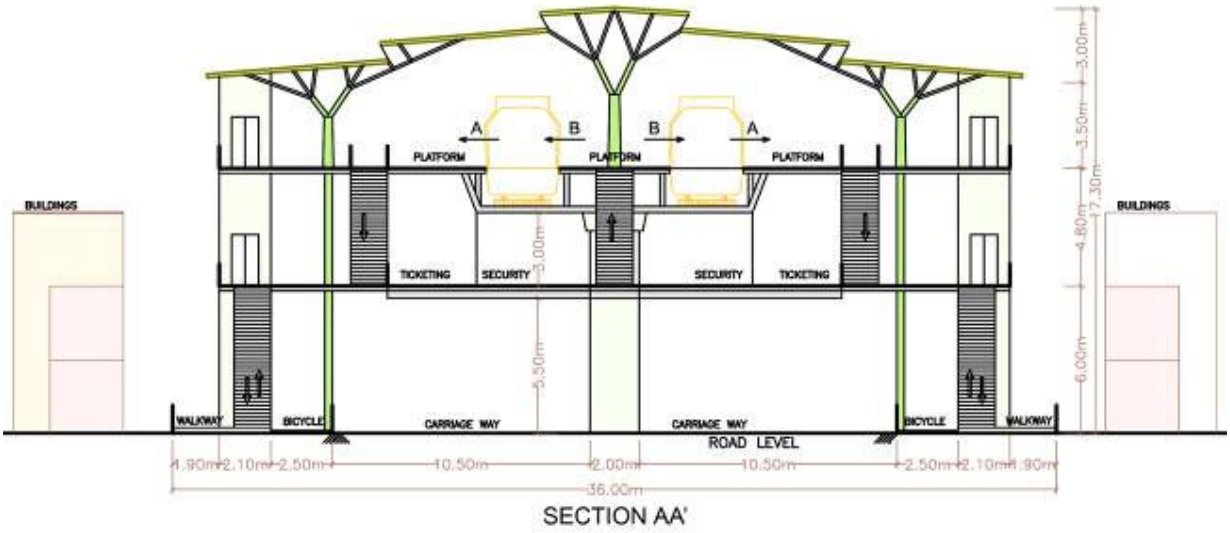
14.2. Station Design for 36m wide road

14.2.1. Station Design

View of Metro station on 36m wide road

View at platforms level. In this view we can observe more natural light is allowed at the platforms level by introducing large openings and also with roof glass. And also provision for natural ventilation from sides and at the roof level.

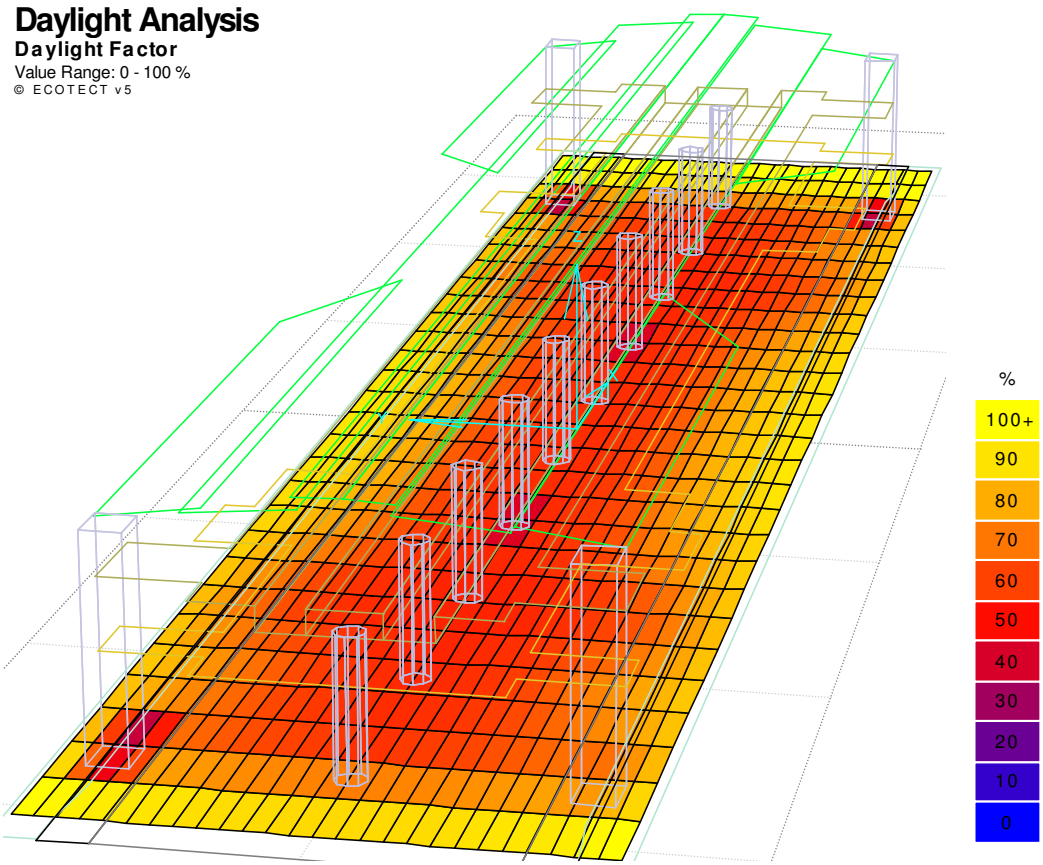

Station Design for 36m wide road
WALKWAY
BICYCLE
CARRIAGE WAY
CARRIAGE WAY
BICYCLE
WALKWAY
A
A'
GROUND FLOOR PLAN
L - LIFT
S - STAIRCASE
E - ESCALATOR
B - BOARDING
A - ALIGTING
T - TICKET COUNTER
STATION MANAGER
SURVEILLANCE
STAFF REST / LOCKERS ROOM
CLOAK ROOM
GENTS TOILET
LADIES TOILET
MEDICAL ROOM
SECURITY
FIRST FLOOR PLAN
ALIGTING PLATFORM
BOARDING PLATFORM
ALIGTING PLATFORM
BOARDING PLATFORM
ALIGTING PLATFORM
SECOND FLOOR PLAN
TRAIN (6-COUCH)



SECTION AA'

14.2.2. Daylight Analysis

Station on 36m wide road



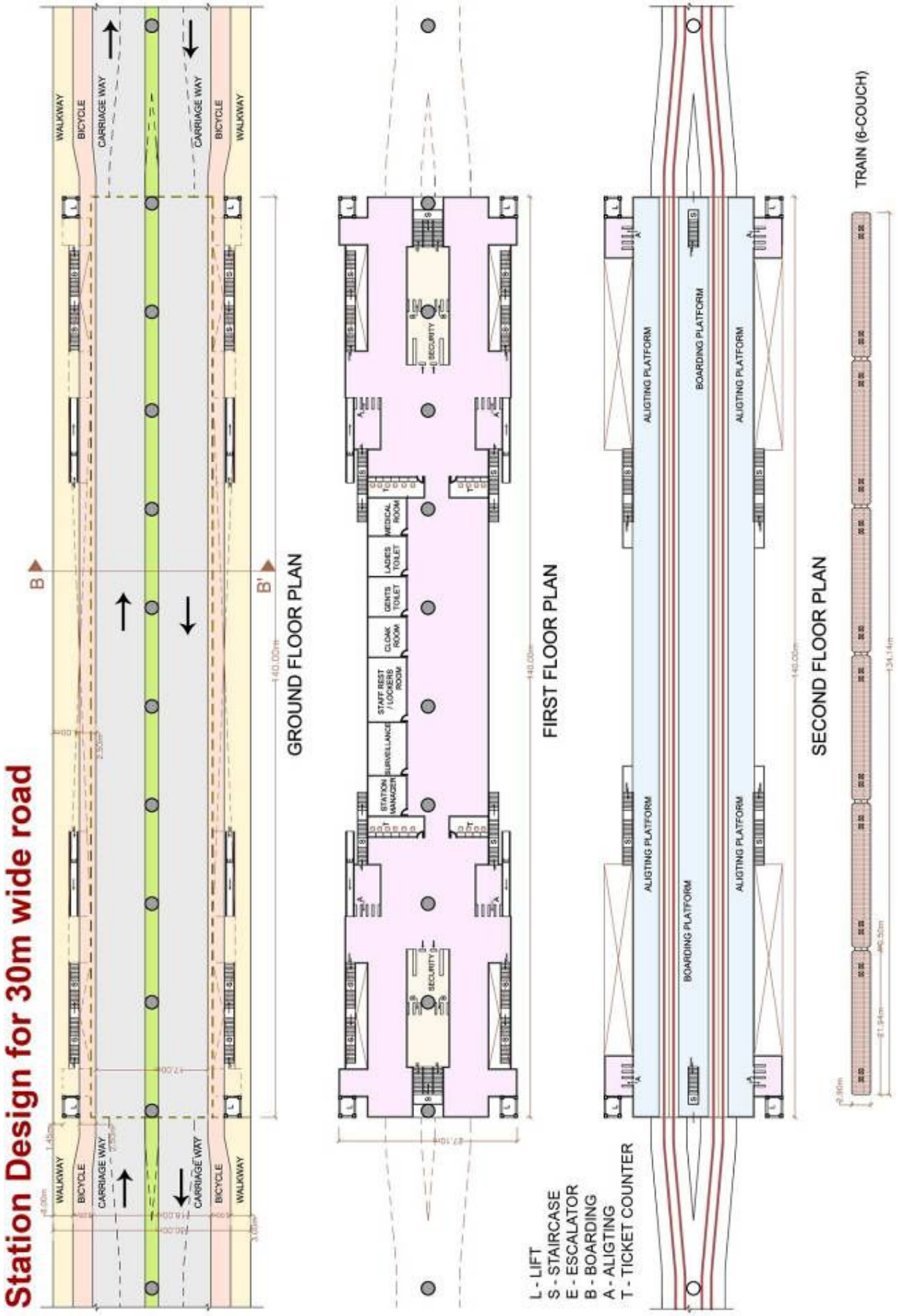
In the day light analysis we can observe more day light is allowed at the road level by introducing large openings and also not covering full width of the road. The daylight at Road level received ranging about 50% near median to 90% at the edges of the road.
And also provision for natural ventilation from sides.

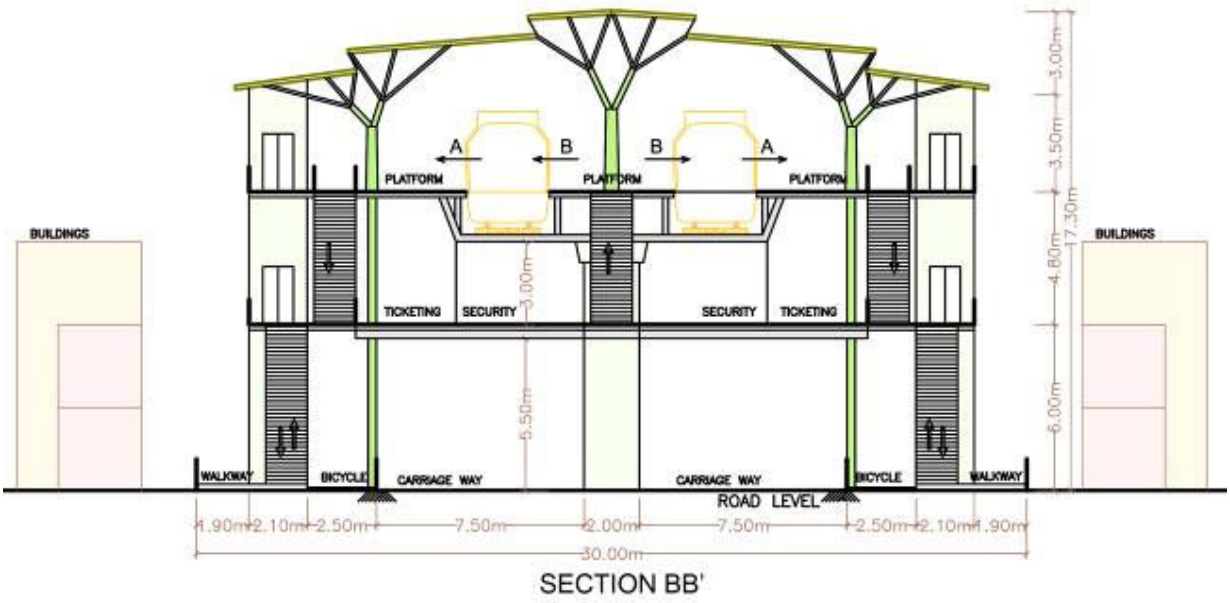
14.3. Station Design for 30m wide road

14.3.1. Station Design

View of Metro station on 30m wide road

View at platforms level. In this view we can observe more natural light is allowed at the platforms level by introducing large openings and also with roof glass. And also provision for natural ventilation from sides and at the roof level.

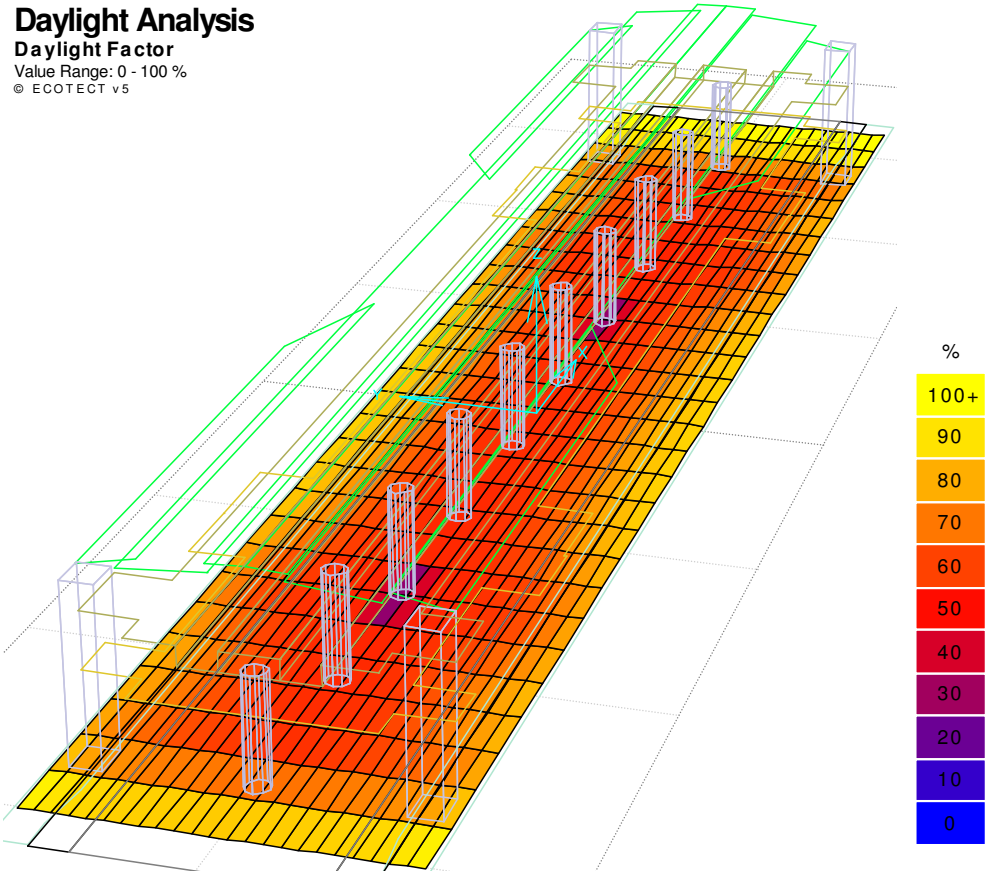

Station Design for 30m wide road
WALKWAY
BICYCLE
CARRIAGE WAY
B
B'
GROUND FLOOR PLAN
STATION MANAGER
SURVEILLANCE
STAFF REST / LOCKERS ROOM
CLOAK ROOM
GENTS TOILET
LADIES TOILET
MEDICAL ROOM
SECURITY
FIRST FLOOR PLAN
ALIGTING PLATFORM
BOARDING PLATFORM
SECOND FLOOR PLAN
TRAIN (6-COUCH)
L - LIFT
S - STAIRCASE
E - ESCALATOR
B - BOARDING
A - ALIGTING
T - TICKET COUNTER



SECTION BB'

14.3.2. Daylight Analysis

Station on 30m wide road



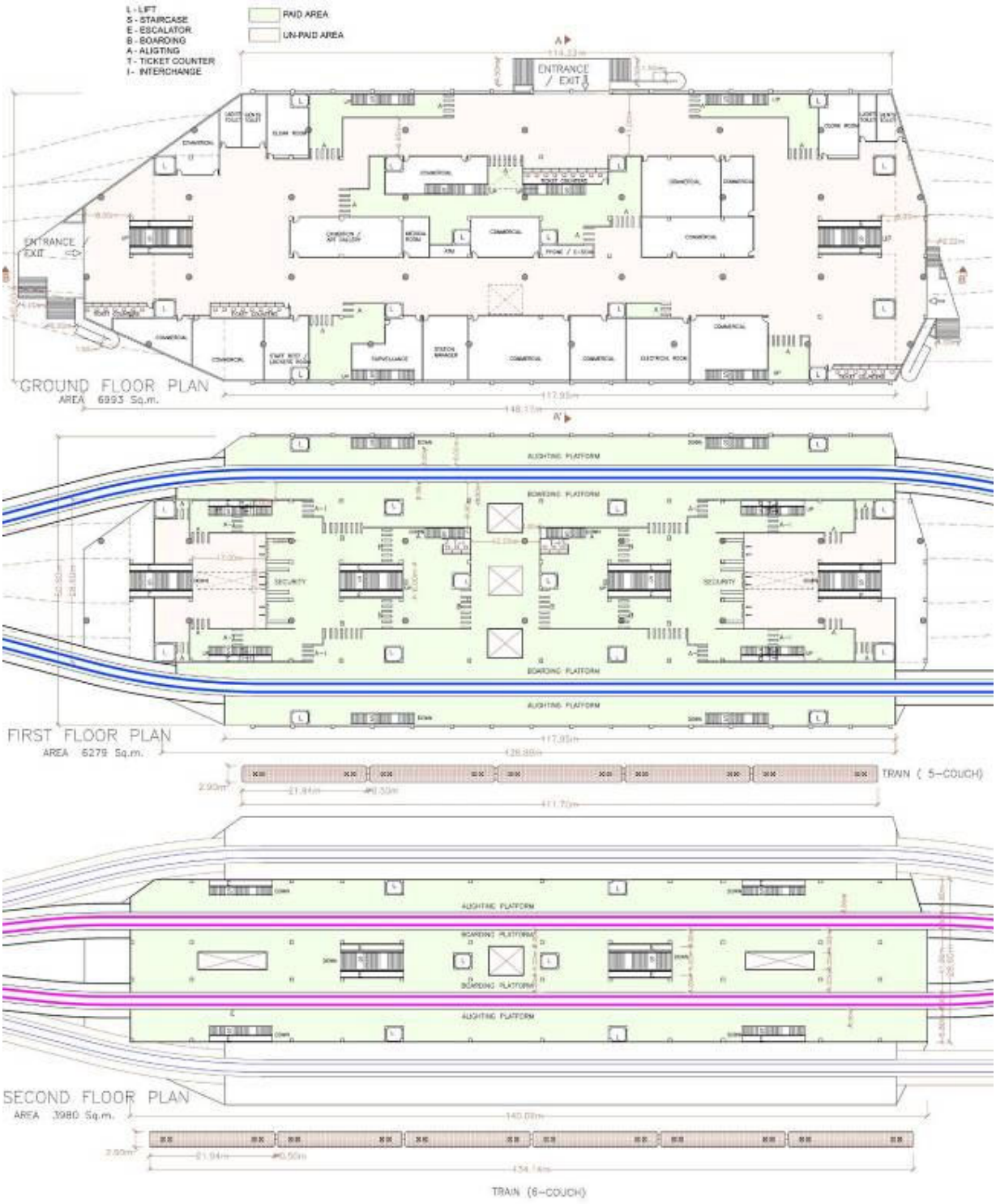
In the day light analysis we can observe more day light is allowed at the road level by introducing large openings and also not covering full width of the road. The daylight at Road level received ranging about 50% near median to 90% at the edges of the road.
And also provision for natural ventilation from sides.

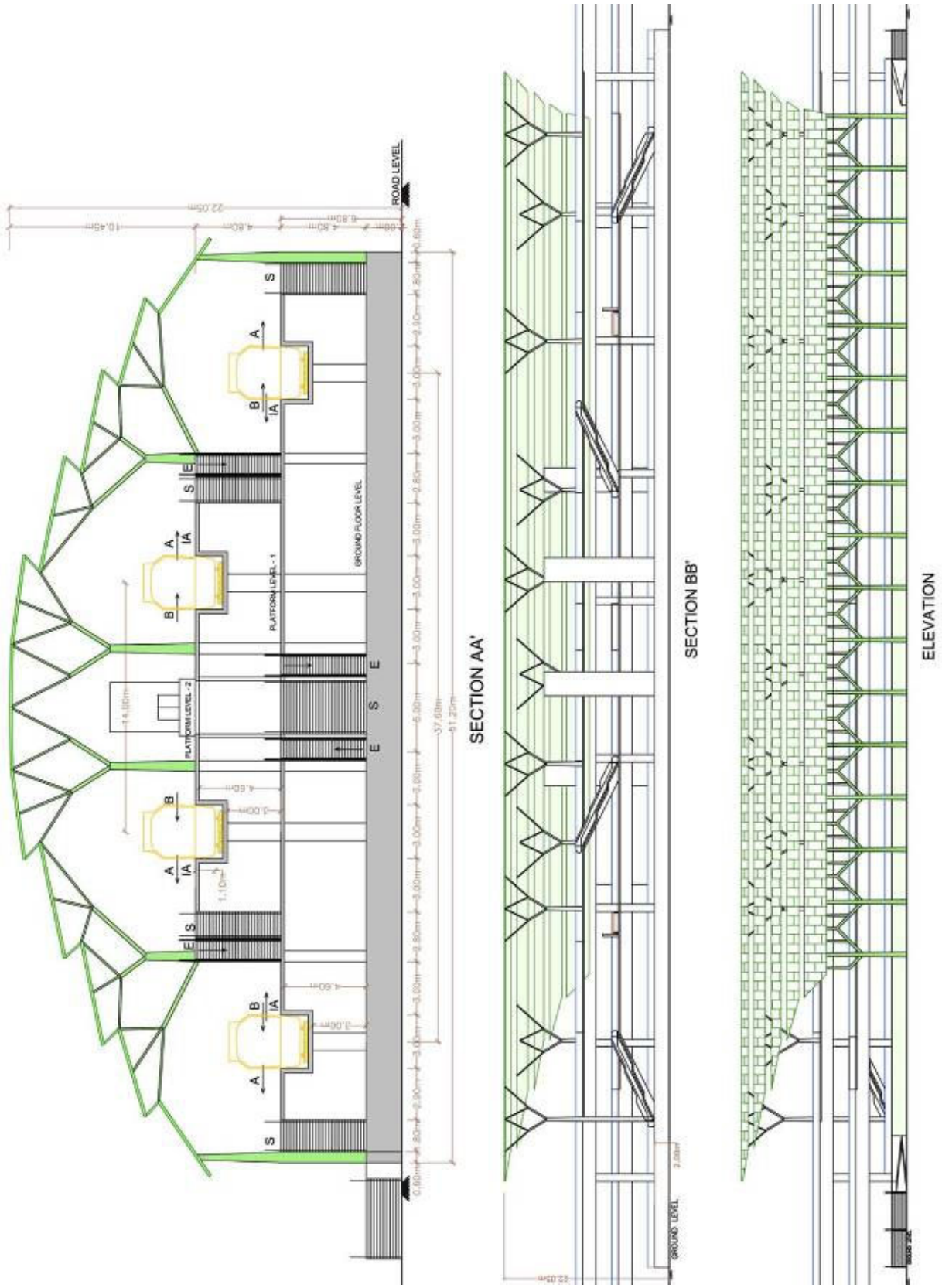
15 METRO STATION DESIGN
MGBS INTERCHANGE STATION

15.1. MGBS interchange metro station design

- The part of the site of area 3.776 acre land of MGBS bus station is allotted for Metro station. It is surrounded with Musi River.
- The proposed MGBS Metro station is designed to suit the requirements of interchange metro station. Here two corridors JBS-Falaknuma and Miyapur-LB nagar are intersecting.
- It is designed to understand the function of the station, track alignment, clearances, light and ventilation inside the station and accessibility, etc.
- The vertical circulation and accessibility to the station is through Staircases, lifts and escalators.
- For the accessibility to the station two new bridges are designed on both sides of the station.
- There are three entrances provided for the station for better and speed accessibility.
- Parking space for two wheelers and four wheelers are provided.
- Access is provided to go to the MGBS bus station for better integration of both transports.
- At the ground floor level Ticket counters, commercial spaces and management spaces are provided.
- The first floor level is worked as the concourse level. Security checks, automatic fare collection machines and interchange spaces are provided at this level.
- The second floor level is only the platforms level. It is designed as per the flow-through platforms concept to speed up the boarding and alighting of the passengers. The central platform is meant for boarding, and the side platforms are meant for alighting.
- The Access and security check points are arranged on both sides to speed up the circulation of the people.
- The roof of the station is designed to provide sufficient light and ventilation at the platform level. Large openings are provided at all levels to have better access of light and ventilation.


TO MAHABOOB MARKET
TO SALARJUNG MUSEUM
BUS STOP
Musi River
VEHICLES BRIDGE PEDESTRIANS
Musi River
ENTRANCE FROM MGBS
PARKING AREA 2800 Sq.m
MGBS Metro Station
MG Bus Station
SITE PLAN
Site for Proposed Metrorail station Area 14836 Sq.m 3.776 Acre
Musi River
VEHICLES BRIDGE PEDESTRIANS
TO UPPAL
Site Area 14836 Sq.m
Builtup Area 17252 Sq.m
Parking Area 2577 Sq.m
Plinth Area 6993 Sq.m
Open Area 5266 Sq.m

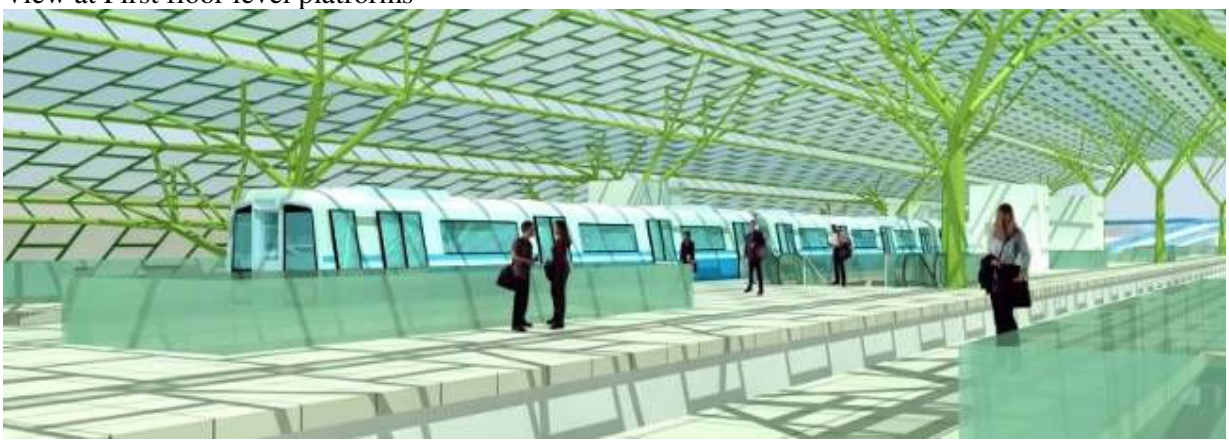

L - LIFT
S - STAIRCASE
E - ESCALATOR
B - BOARDING
A - ALIGTING
T - TICKET COUNTER
I - INTERCHANGE
PAID AREA
UN-PAID AREA
ENTRANCE / EXIT
GROUND FLOOR PLAN
AREA 6993 Sq.m.
ALIGHTING PLATFORM
BOARDING PLATFORM
SECURITY
FIRST FLOOR PLAN
AREA 6279 Sq.m.
TRAIN (5-COUCH)
SECOND FLOOR PLAN
AREA 3980 Sq.m.
TRAIN (6-COUCH)


ROAD LEVEL
GROUND FLOOR LEVEL
PLATFORM LEVEL - 1
PLATFORM LEVEL - 2
SECTION AA'
SECTION BB'
ELEVATION

View from MGBS bus station

View from parking side

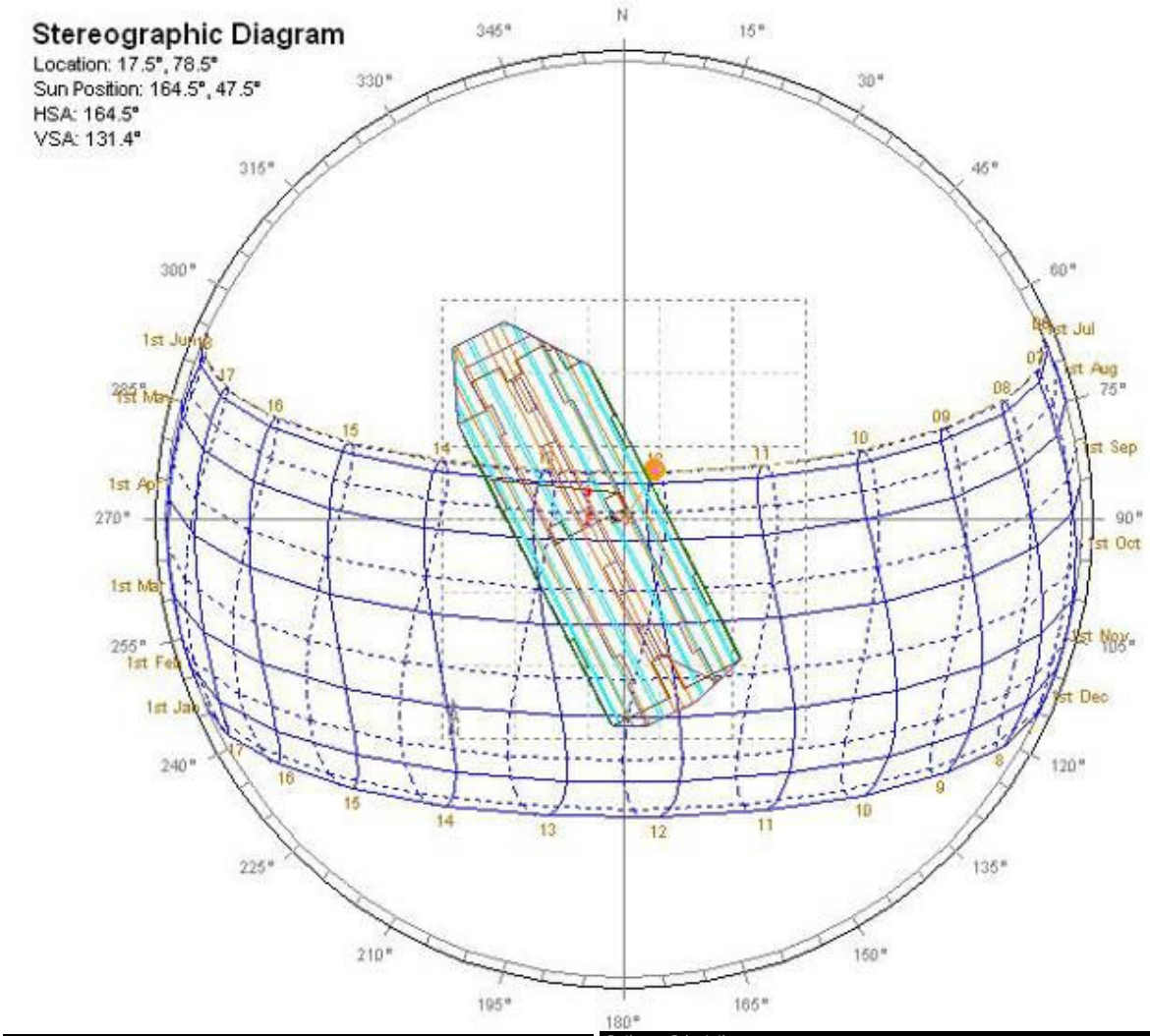
View at First floor level platforms

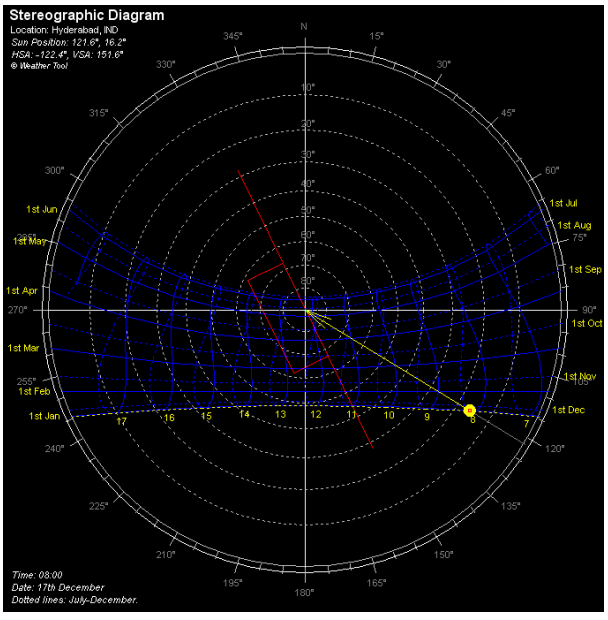


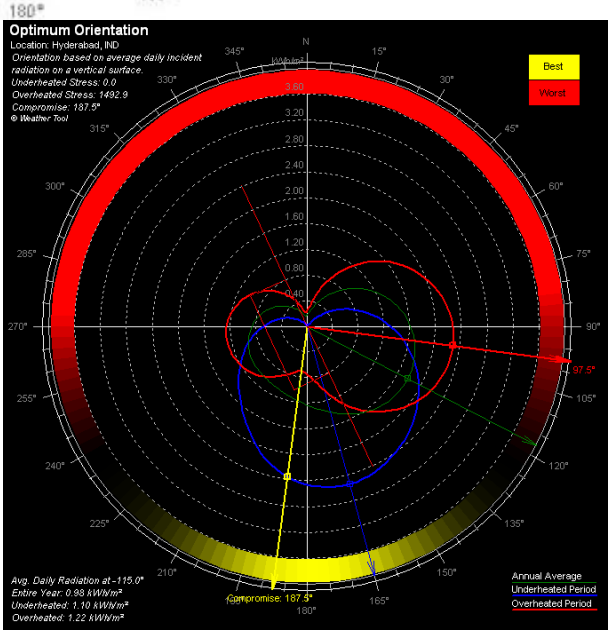
View at Second floor level platforms

15.2. Metro Station Building Analysis

15.2.1. Orientation of the Metro Station Building

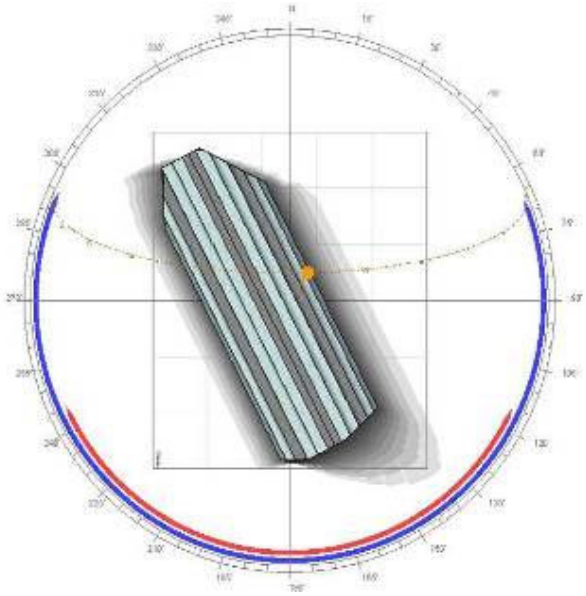




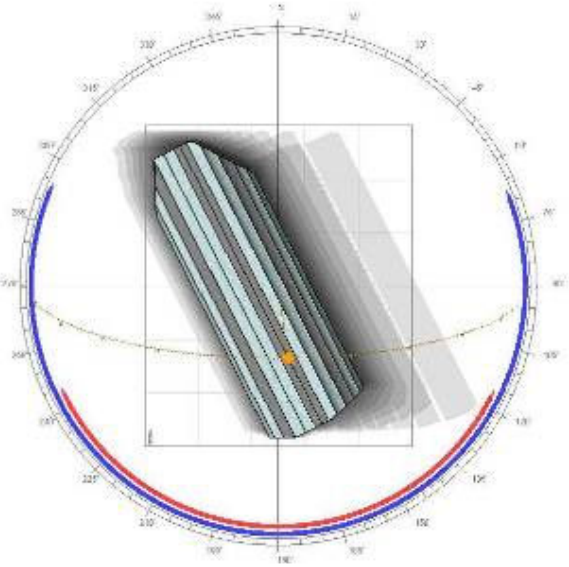


15.2.2. Shadow Analysis

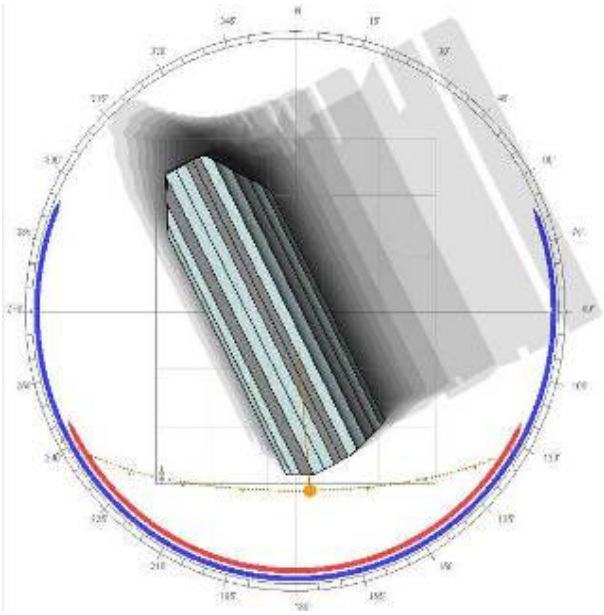
Shadow range – Summer
21 June 9am-5pm



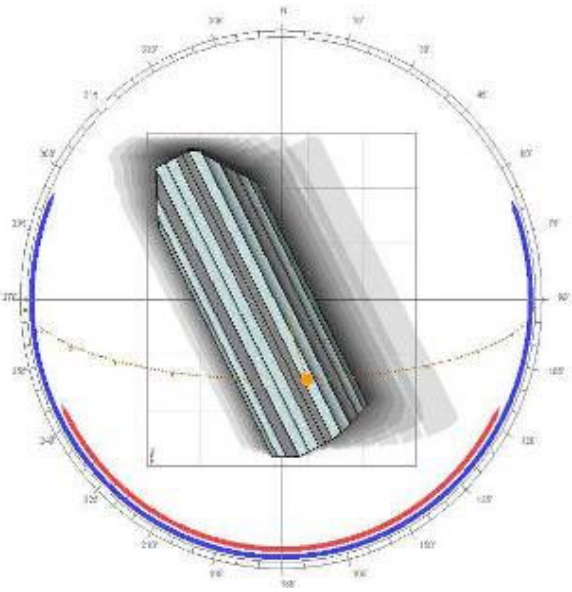
Shadow range – Autumn
21 September 9am-5pm



Shadow range – Winter
21 December 9am-5pm

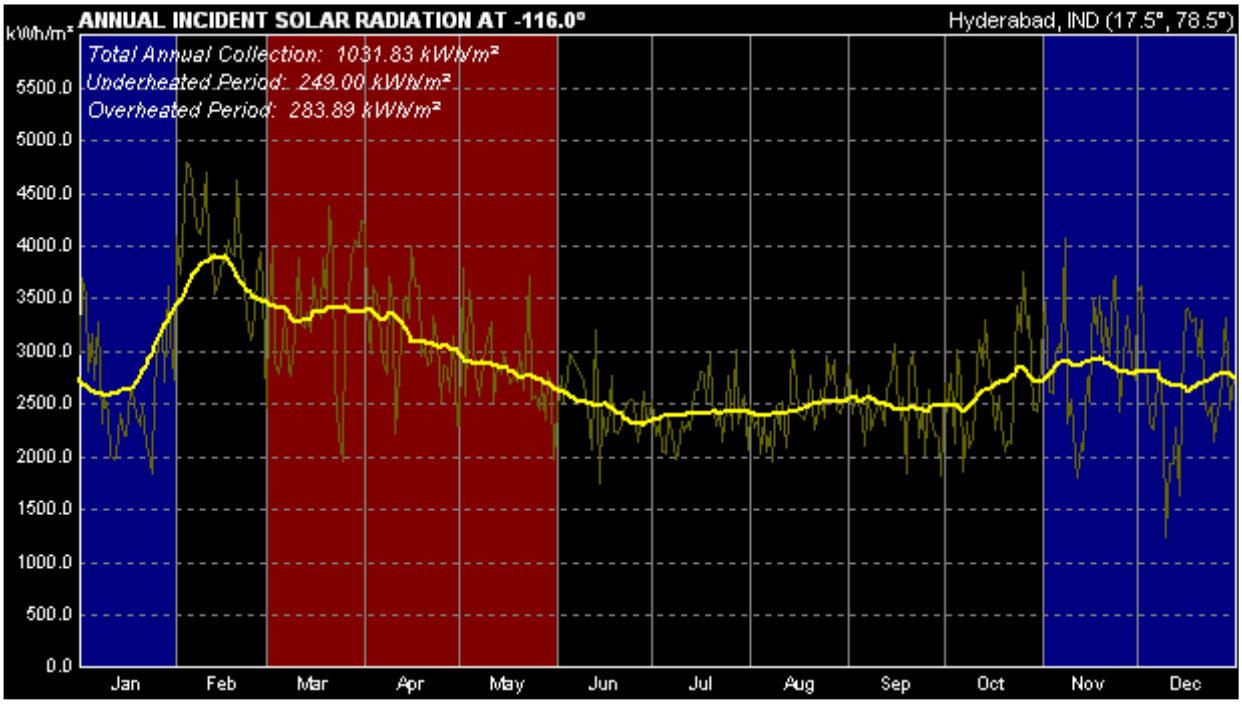


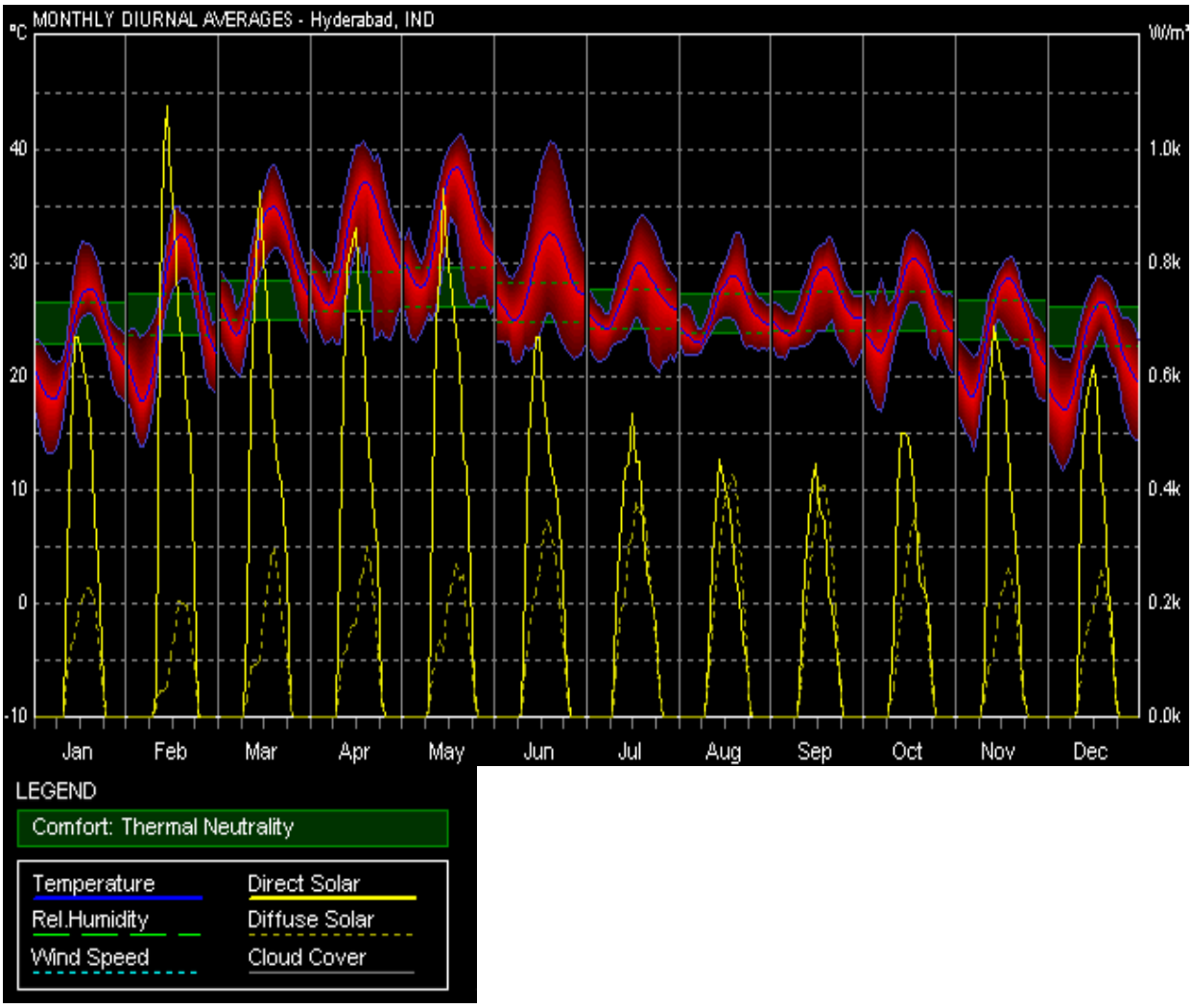
Shadow range – Spring
21 March 9am-5pm



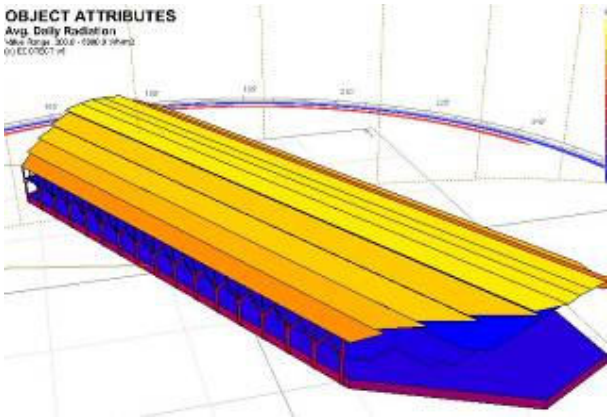
From the shadow analysis we can observe most of the time the parking area side is covered with shadow.

15.2.3. Solar Radiation

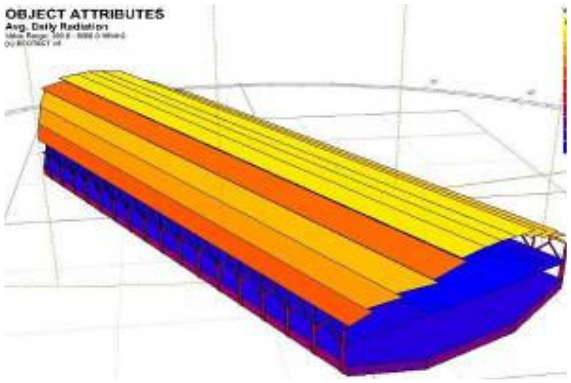


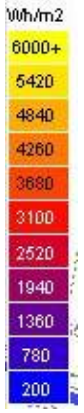


Summer NE view

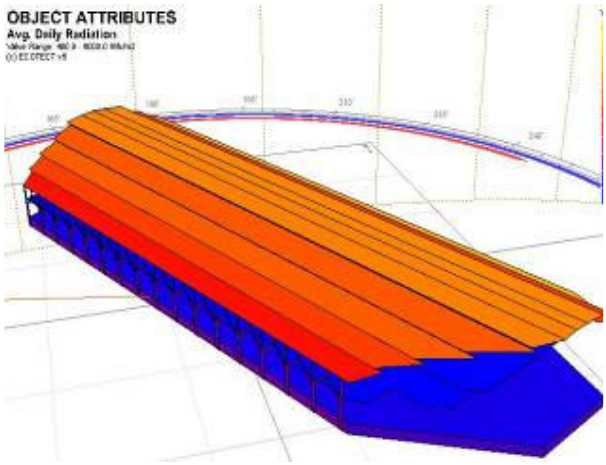


Summer SW view

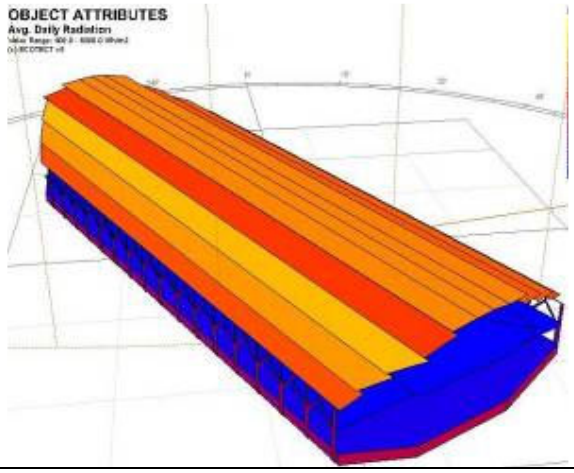




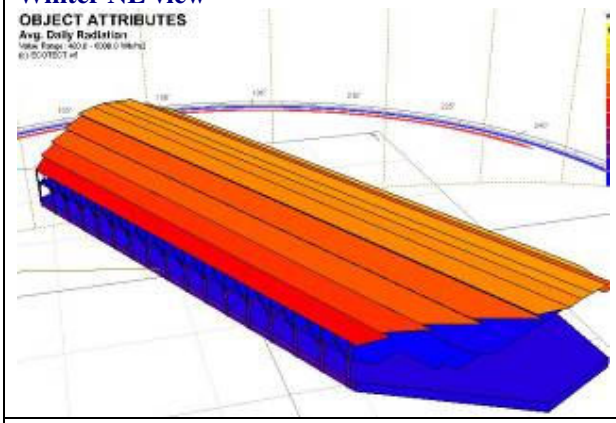
Autumn NE view



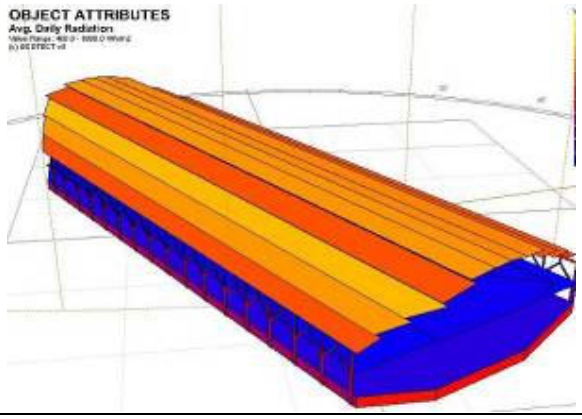
Autumn SW view



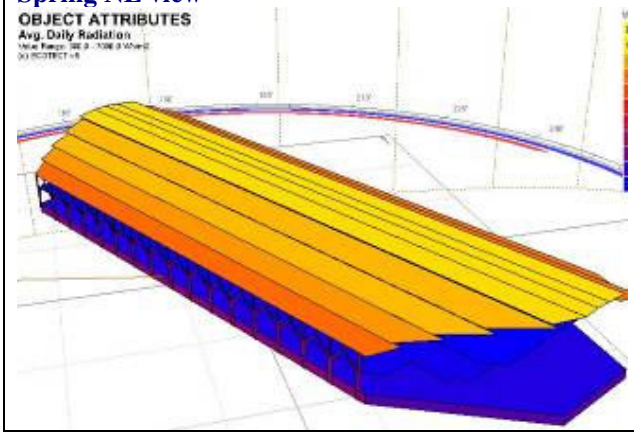
Winter NE view



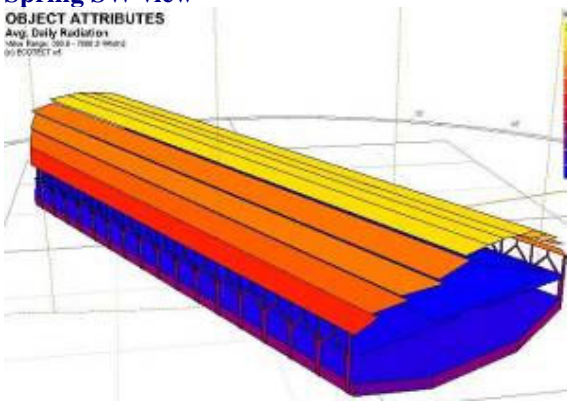
Winter SW view



Spring NE view

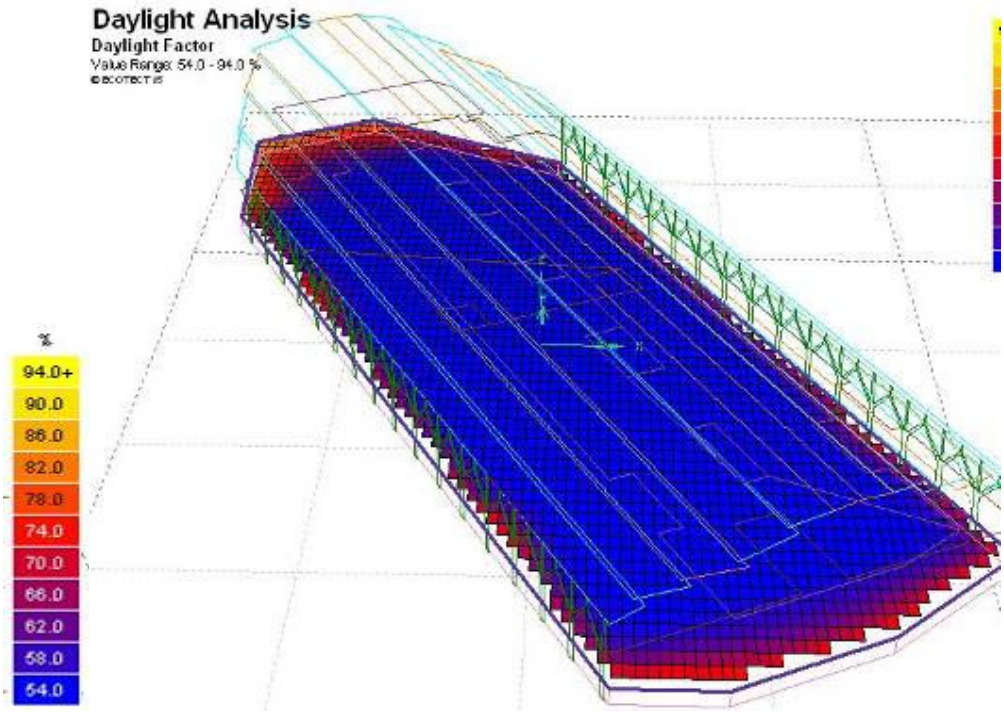


Spring SW view



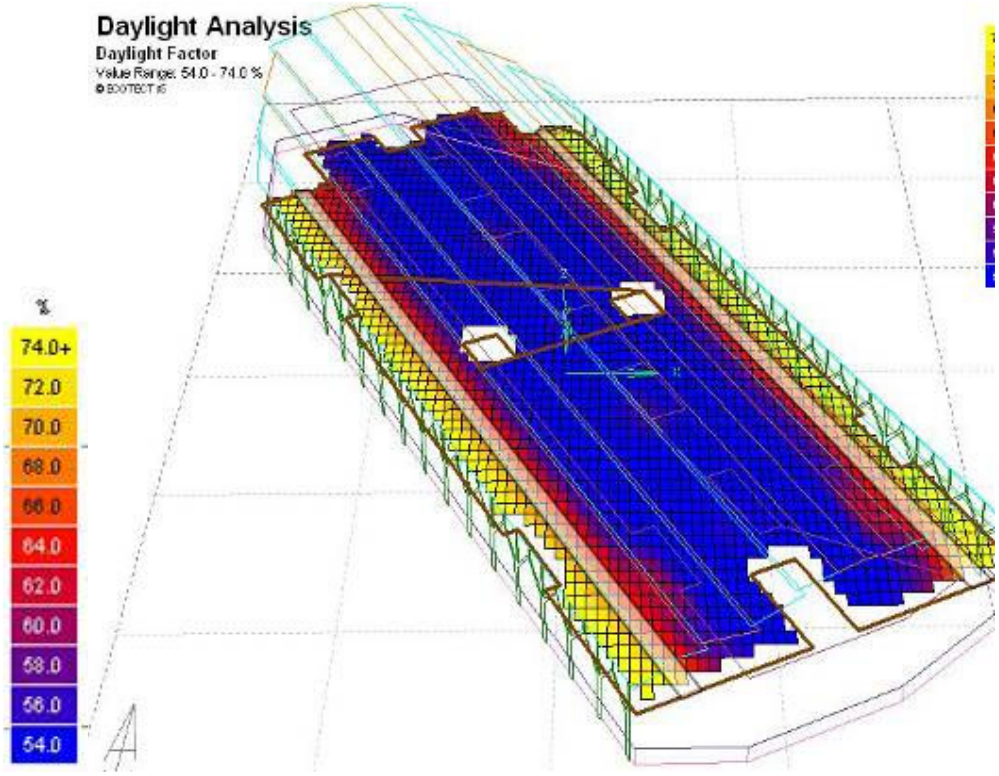
15.2.4. Daylight Analysis

Ground Floor



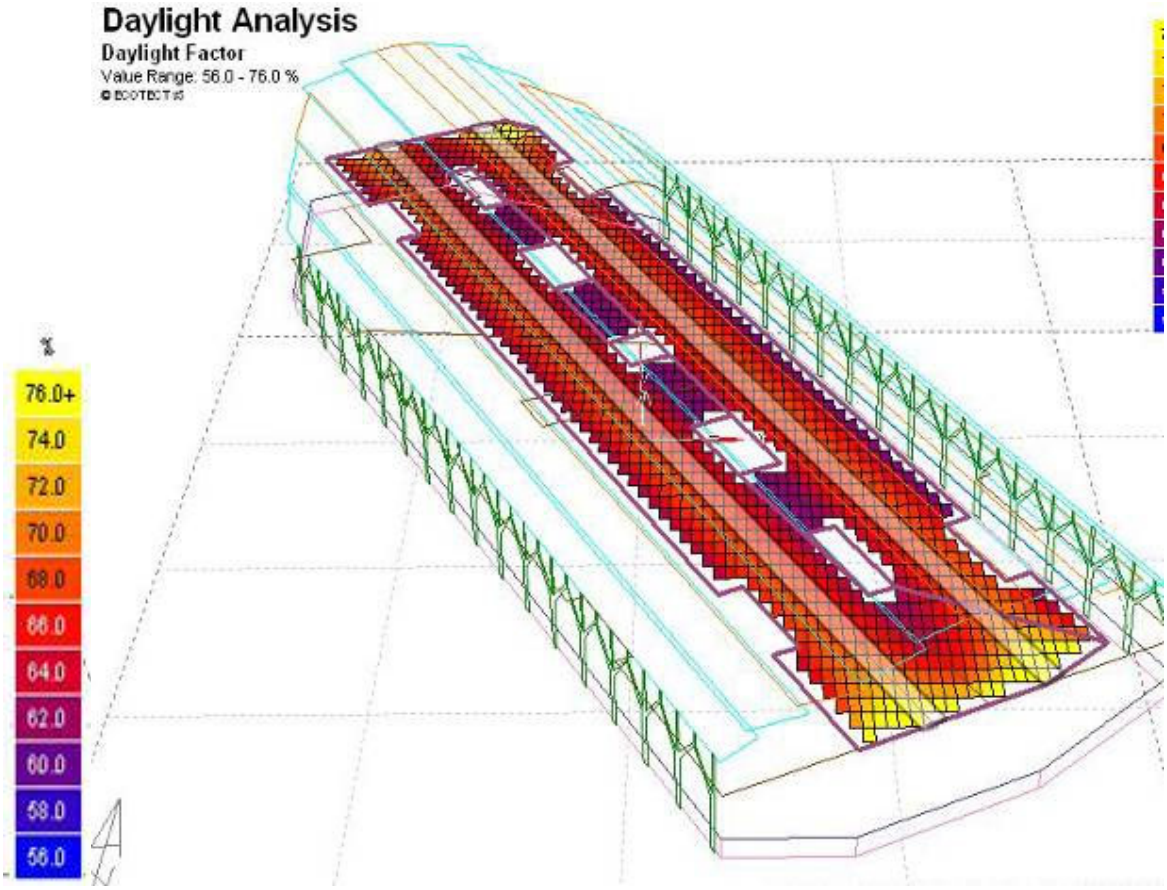
In the day light analysis we can observe sufficient day light is allowed at the Ground floor level by introducing large openings. The daylight at Ground floor level received ranging about 54% at central spaces to 78% at the edges. And also there is a provision for natural ventilation from sides.

First Floor



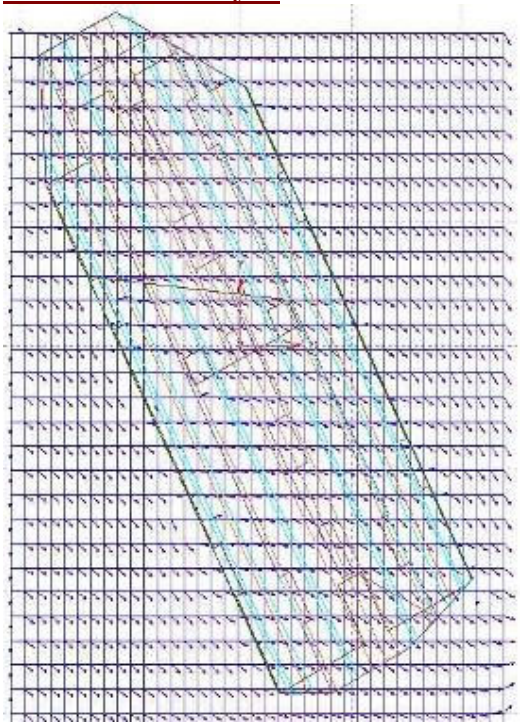
In the day light analysis we can observe sufficient day light is allowed at the First floor level by introducing large openings. The daylight at First floor level received ranging about 54% at central spaces to 74% at the edges and platforms. And also there is a provision for natural ventilation from sides and roof.

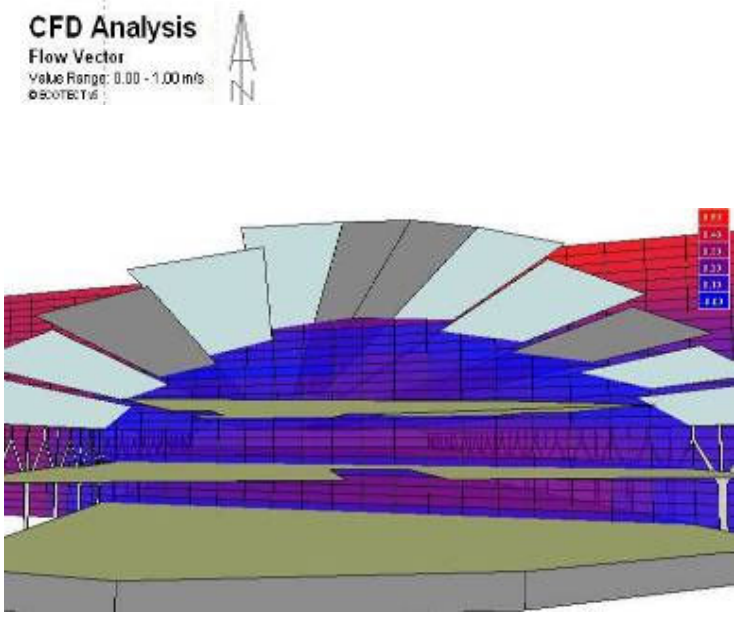
Second Floor



In the day light analysis we can observe sufficient day light is allowed at the Second floor level by introducing large openings. The daylight at Second floor level received ranging about 62% at centeral spaces to 76% at the edges and platforms. And also there is a provision for natural ventilation from sides and roof.

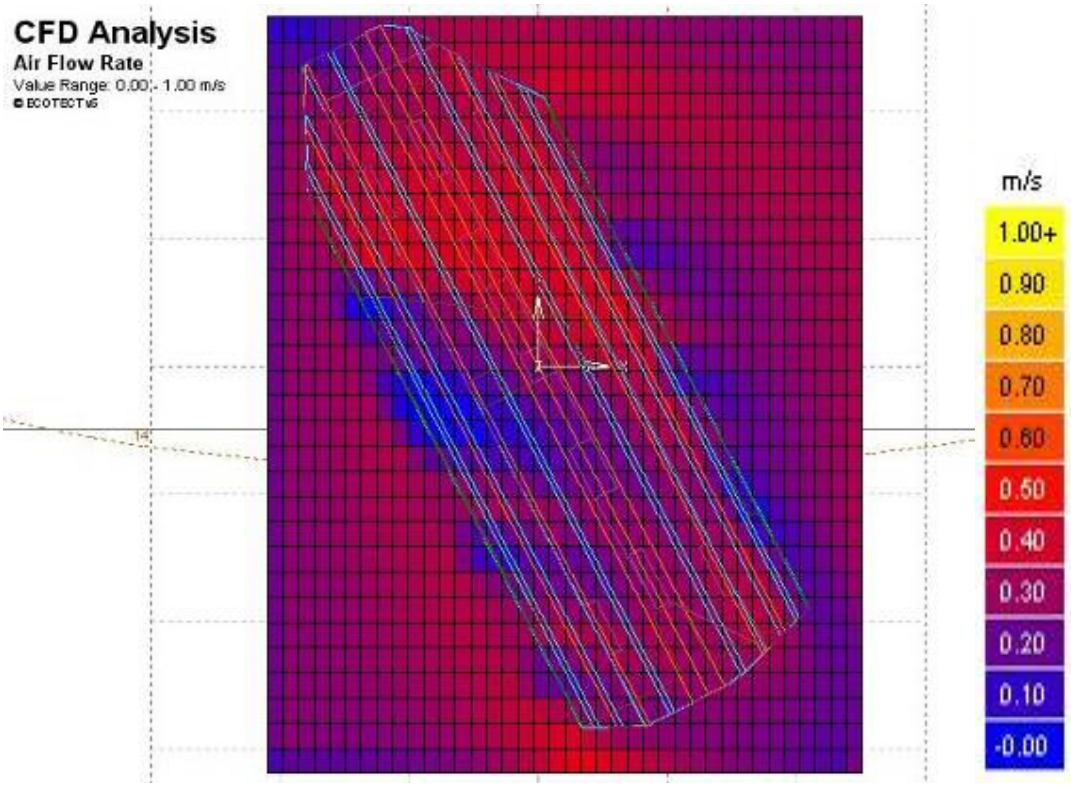
15.2.5. Wind Analysis



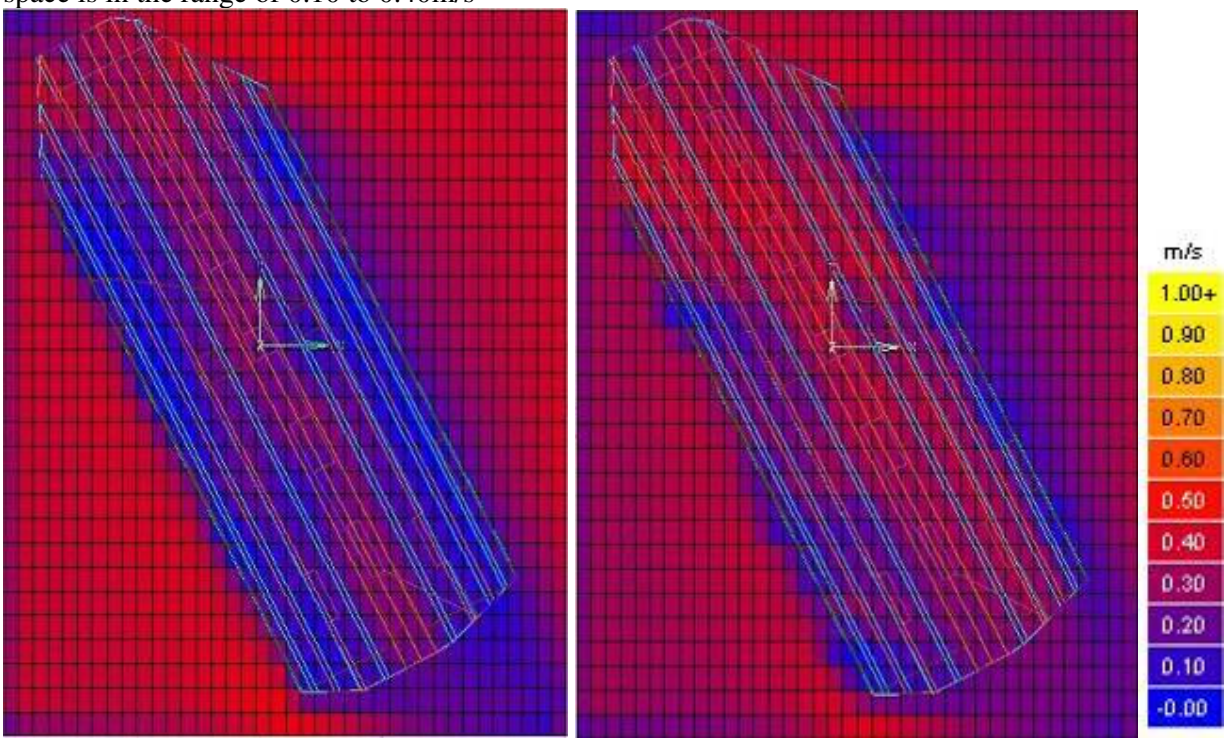


Section

Ground Floor



In the above figure we can observe maximum space is receiving around 0.50m/s of air. rest of the space is in the range of 0.10 to 0.40m/s

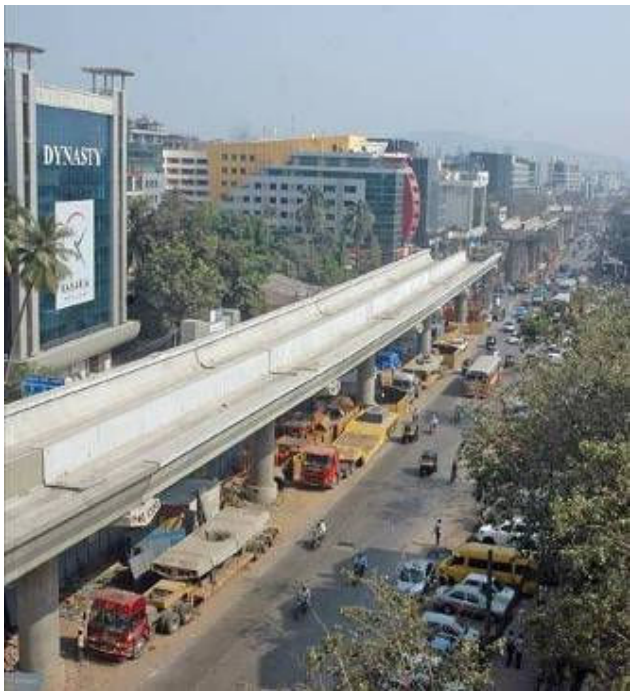


First Floor **Second Floor**

(First floor) In the above figure we can observe maximum space is receiving around 0.50m/s of air. Rest of the space is in the range of 0.10 to 0.40m/s. (Second floor) In the above figure we can observe maximum space is receiving around 0.35m/s of air. Rest of the space is in the range of 0.10 to 0.30m/s.

16 IMPACT & MITIGATION

Any infrastructure development carried out in the city is meant for the people living in the city. Therefore there should be proper designing and implementation to minimize the impact on the environment, so that there will be minimum inconvenience or no-inconvenience for the people.



16.1. Elevated Metro is better than Underground Metro

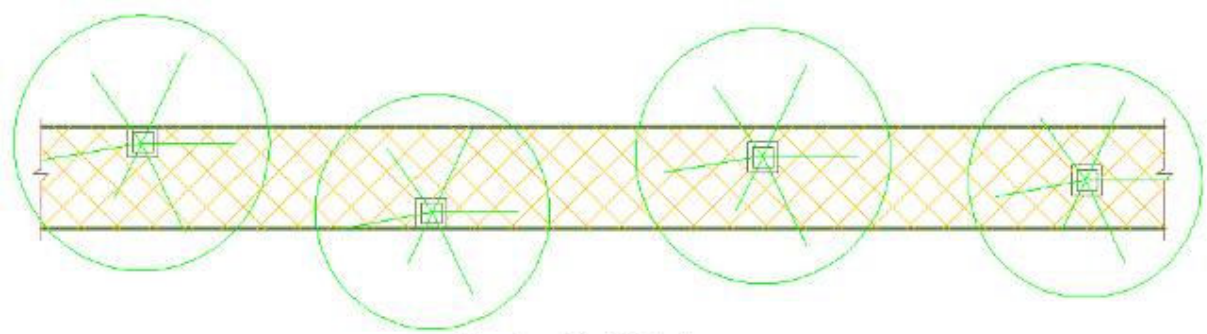
In the study area the construction of elevated metro will have less impact on environment than underground. The points observed are as follows:

- The topography of surface level is not flat, and it is difficult to dug tunnel for underground.
- Cut and cover method is impossible at these areas because of lack of space and it will have more impact on traffic and ground water. And also it increases the dust and noise pollution levels during excavation.
- Underground construction is more time consuming and expensive when compared to Elevated construction.
- There is a Musi river in the study area, where it is difficult to handle the underground construction.

- The service lines like sewage, fresh water, electrical cables and others are under the ground. They are below and near the roads, which are very difficult to shift and manage.
- The gradient required is minimum 1 in 25 for metro tracks. There is no enough distance to achieve from elevated to underground.

16.2. Saving trees/vegetation

In the study area there are 164 trees have to be cut down in road widening according to HMR proposals. 94 trees are coming around the footpath line. So these trees can be retained and saved with careful road widening and foot path design. The width of the foot path / walkway should be minimum 3m.



16.3. Minimum demolition of Buildings & Rehabilitation of People

There should be proper design and planning for the widening of the road while metro construction. Unnecessarily more than the requirement, buildings should not be demolished. Because the locality or area loose the character which has been built up for long time. People will also loose business and livelihood. With proper designing the demolition of the buildings and rehabilitation of people can be reduced. In the case of Sultan bazaar area 30m road widening is not necessary as the heavy vehicles are not allowed in this road. And also it is famous for road shopping and very busy road throughout the day. The road widening should be minimum to accommodate metro rail as per norms and the life of this area should not be disturbed. Otherwise the importance of this area will be totally lost. In the study area as per HMR proposal there are 154 buildings are affecting. But with careful design 54 buildings can be saved and retained.

16.4. Impact on water Quality

There will be impact on ground water quality during the construction. Pillars construction in the Musi River also pollutes the surface water. As the river is having less flow and also the impact will be very short term. With proper care and measures the impact can be reduced.

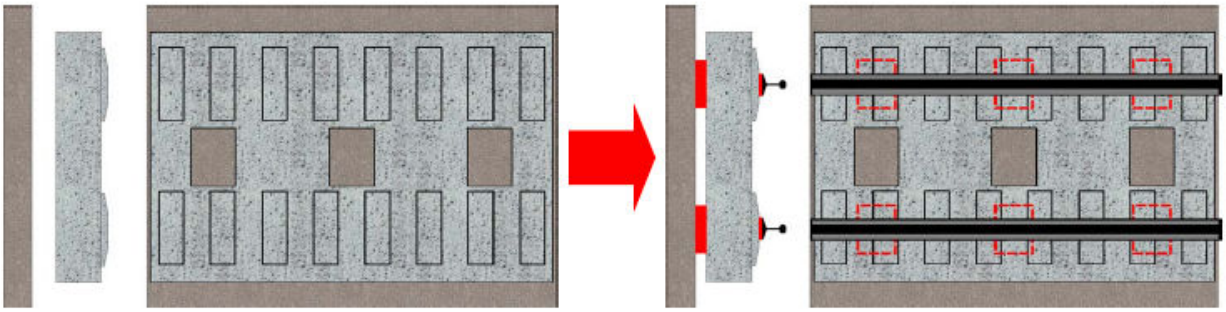
During operation phase the waste water can be connected to municipal sewage line.

16.5. Impact on Air quality

There will be more impact on air quality during the construction because of dust and smoke. This can be reduced with proper care and measures like covering the construction materials, spraying water in the site and proper maintenance of construction equipment and generators.

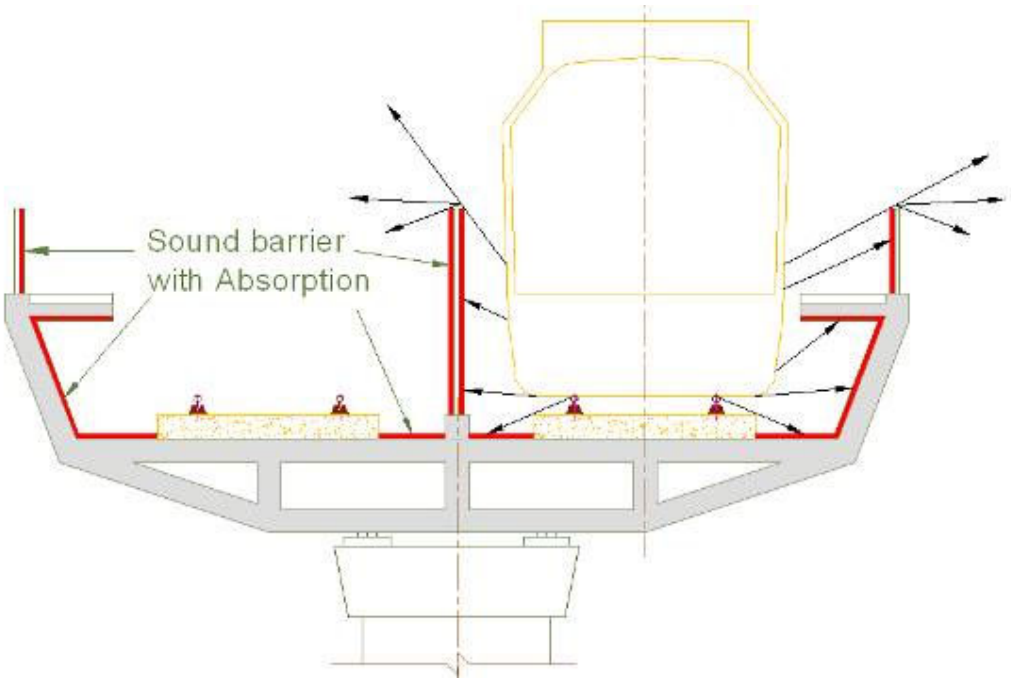
16.6. Vibration

Light and Heavy Mass-Spring-Systems are ideal for Ballast less Track to reduce vibrations.



16.7. Noise pollution

Low noise barriers close to the rail with the low cost and easy to install, the glass sound barrier (noise reduction is around 5 to 10 dB) could be the suitable choice for air-borne noise mitigation. A range of 15-17 dB is practical to be reduced.



16.8. Power Consumption and Generation

Solar panels can be installed on the roof of the metro station buildings, so that it can generate solar power and contributes for building electricity.

With regenerative breaking system installed on the wheels of metro train, power can be generated.

Power consumption can be reduced by allowing maximum daylight in to the station building. And also proper insulation for the building envelope to reduce the heat gain and good cross ventilation in the building, so that load on air-conditions will be reduced.

16.9. Saving Heritage structures

For retaining the significance and value of any city for the ages, it is very important to save its Heritage and Culture. The future generation will have the chance to see the history through the heritage monuments and structures. These are the evidences of the history, need to be preserved and protected. In Hyderabad there are many such buildings, houses, structures which have heritage value.

16.10. Saving Landmarks

Generally people relate any place with the important landmarks, such as buildings, parks, statues, religious places or monuments etc. For example Andhra bank building is the landmark structure in the sultanbazar area. If it is damaged then people feel difficult to relate to this area.

16.11. Saving Religious structures

It is very important that any important religious structure should not be disturbed or damaged for the sake of infrastructure development. Because it relates to the sentiments of the local people and culture. If it is necessary then it should be relocated with care without any damage with the consent of local people.

16.12. Interaction with Local people

It is very important to interact with local people to understand local problems, issues from time to time till the completion of the project.

16.13. Traffic diversion during the Metro construction

During Metro corridor construction the road traffic should be diverted through other routes as far as possible, so that the congestion on the roads are minimized and there will be smooth flow of traffic on the remaining roads after barricading for construction.

16.14. Barricading Metro construction area for public safety

During Metro corridor construction at the middle of the road there should be 9m to 10m of barricading. Therefore the construction activity will not be disturbing the road users. Proper safety measures should be taken, so that there should not be any trespassing of people through construction area. The barricading should not be more than 200-300m, so that people can easily cross the roads.

16.15. Display safety sign boards at the Metro construction sites

By the proper display of safety sign boards at the Metro corridor construction sites, the accidents can be avoided.

16.16. Avoiding delay during the Metro construction

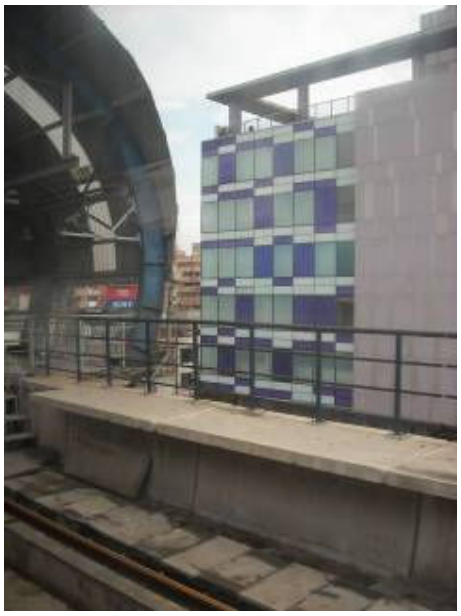
Metro corridor construction activities should be done as per the scheduled, with out any delay. So proper construction management is required to finish the activities on time. Thus there will not be inconvenience for long time to the road users and neighbors.

16.17. Phase wise Construction

The metro rail constructions should be carried out in the phase wise for the convenience of road users and the local people. If the construction carried out at a time for long distances, the people will suffer to go through those areas, and also the people loose business because of less people use those roads.

16.18. Privacy and Safety for Adjacent buildings of Metro stations

Sufficient distance should be maintained from adjacent buildings while construction of metro corridor and metro stations as per the building by-laws. So that the privacy for the people residing in the adjacent people will be maintained. And there will be lesser chance of terrorist attacks on metro from the buildings.



16.19. Integration with Bus transportation

When the metro rail integration with bus transport, the people prefer to use the public transportation comfortably as it will be convenience to switch between these modes of travel. So the location of metro stations should be near to the bus stops or bus stations.

16.20. Bicycle paths

Bicycle ways should be provided all along the roads on either side. By providing dedicated bicycle paths the vehicular traffic on roads can be minimized. It is also safe for bicycle users. The environmental pollution is also reduced. The width of the bicycle path should be minimum 3m.

16.21. Bicycle Rental points

Bicycle rental points can be installed near the Metro stations. So that, the people using metro trains will be benefited by the bicycle rental system. Usually people relay on other private transportation such as autos, cars, or buses to go around the place. By this bicycle rental system usage of other vehicles will be reduced. Pollution can be reduced.

16.22. Safety on platforms

The Hyderabad metro rail power supply is through third rail system. As it is fixed beside rails, it may pose danger to the people who fall accidentally on the tracks. So there should be a glass railing with automatic sliding doors on the platform edges towards rail track. Whenever train comes the doors will open for the passengers. Therefore the system provides safety to the people.

16.23. Feeder transportation system for Metro

The effective feeder vehicles for transporting people to metro stations from near by areas can reduce the usage of private vehicles. So that the number of vehicles on roads can be reduced, thus the vehicular pollution will be reduced.

16.24. No scope for Anti-social activities

Under the metro stations there will be road and it looks like a lengthy tunnel with a minimum length of 120m to 140m. These kinds of dark tunnels may pose threat to anti-social activities and terrorist attacks. So by provision of more natural light in these areas, it can reduce darkness and allows for smooth flow of traffic.

16.25. Promoting local Culture and Art at Metro stations

The metro stations will be very ideal and special locations to reach the large crowds. The local art and culture can be exhibited at the station. They can be through wall paintings, exhibition halls, stalls and wall mountings, sculptures and small shows and presentations etc.

16.26. Saving time is saving energy

At the busy metro stations where more people use metro, there should me more ticket counters and security check points. So that it can avoid long queues for ticket purchasing and security checks. So that it saves lot of time for people, so energy is saved.

16.27. More trains during peak hours

For the people convenience and to reduce the heavy rush during peak hours more trains should be introduced.

17 ABBREVIATIONS

ABBREVIATIONS

APPCB	-	Andhra Pradesh Pollution Control Board
APSRTC	-	Andhra Pradesh Road Transport Corporation
BRTS	-	Bus Rapid Transit System
CFC	-	Chlorofluorocarbons
CPCB	-	Central Pollution Control Board
CRRI	-	Central Road Research Institute
CSE	-	Centre for Science and Environment
DMRC	-	Delhi Metro rail Corporation
EIA	-	Environmental Impact Assessment
GHG	-	Greenhouse gases
HMRC	-	Hyderabad Metro rail Corporation
HUDA	-	Hyderabad Urban Development Authority
IEA	-	International Energy Agency
IISD	-	International institute for Sustainable Development
IPCC	-	Intergovernmental Panel on Climate Change
IT	-	Information Technology
INTACH	-	Indian National Trust for Art and Cultural Heritage
ITES	-	Information Technology enabled services
JBS	-	Jubilee bus station
JNNURM	-	Jawaharlal Nehru National Urban Renewal Mission
LRT	-	Light Rail Transit
MCH	-	Municipal corporation of Hyderabad
MMTS	-	Multi Model Transport System
MRT	-	Mass Rapid Transit
MRTS	-	Mass Rapid Transit System
OICA	-	Organization Internationale des constructeurs d'Automobiles

PHPDT	-	Peak hour peak direction traffic
PPM	-	Parts per million
PTS	-	Public Transportation System
PCB	-	Polychlorinated biphenyls
RSPM	-	Respirable suspended particulate matter
SCR	-	South Central Railway
TSPM	-	Total suspended particulate matter
ULB	-	Urban local body
UN ESCAP	-	United Nations Economic and Social Commission for Asia and the Pacific

18 ANNEXURE

(Note: This questionnaire is intended to use for academic purpose only. Questionnaire is prepared by J.V.Umamaheswara Rao (M.Arch-ED), SPA, JNAFAU, Masabtank, Hyderabad)

18.1. Questionnaire – 1 (Traveling people in the routes of proposed Metro rail project JBS-Falaknuma route (Corridor-II Hyderabad Metro.)

Date: _____Time of Interview: _____Place of Interview: _____

1. Name: _____
2. Gender: ( ) Male ( ) Female
3. Age: _____
4. Education: ( ) illiterate ( ) primary / high school ( ) 10th ( ) 10+2 or Inter
   ( ) Graduate ( ) Post Graduate ( ) Diploma ( ) Others_____
5. Occupation: ( ) Unemployed ( ) Student ( ) Home maker ( ) Retired
   ( ) Self employed ( ) Government Employee ( ) Private employee ( ) Wage labourer
   ( ) Skilled worker ( ) Petty trader ( ) Others _____
6. Place of Residence: _____
7. Place of work / study: _____
8. Which type of transportation you are using for traveling?
9. Did you hear of proposed Metro rail construction in this route as major project?
10. Do you think Metro rail would be the best public transportation facility compared to MMTS and RTC buses? ( ) Yes ( ) No Reason _____
11. Do you think Hyderabad city requires Metro rail project to solve traffic problems?
    ( ) Yes ( ) No Reason_____
12. Metro rail runs at the middle of the roads and at the height of 35-50 feet continuously. Do you think it spoils the beauty of the Hyderabad? ( ) No ( ) Yes
13. Metro rail stations are built for every 1km on the roads, and they are like series of tunnels to travel on the road. Your opinion _____
14. If Metro rail project construction starts, what measures you are going to take to face the dust, sound pollution and traffic jams? _____
15. What facilities you expect at Metro rail stations _____
16. Do you suggest any safety measures at Metro rail stations _____
17. Do you prefer to travel on Metro rail? ( ) No ( ) Yes ; Reason_____
18. Your opinion on impact of Metro rail project on Hyderabad city Environment:
    _____

18.2. Questionnaire -2 (People living along the corridors of proposed Metro rail project JBS-Falaknuma route (Corridor-II Hyderabad Metro.)

Date: _____Time of Interview: _____Place of Interview: _____

1. Name: _____
2. Gender: ( ) Male ( ) Female
3. Age: _____
4. Education: ( ) illiterate ( ) primary / high school ( ) 10th ( ) 10+2 or Inter
   ( ) Graduate ( ) Post Graduate ( ) Diploma ( ) Others_____
5. Occupation: ( ) Unemployed ( ) Student ( ) Home maker ( ) Retired
   ( ) Self employed ( ) Government Employee ( ) Private employee
   ( ) Wage labourer( ) Skilled worker ( ) Petty trader ( ) Others _____
6. Place of Residence: _____
7. Place of work: _____
8. For how many years you have been residing in this locality? _____
9. Did you hear of proposed Metro rail construction in this route as major project?
10. Is your Land / building affecting in Metro rail project road widening?
    ( ) No ( ) Yes, how much area _____
11. If your property is affecting in road widening, are you getting any compensation?
    ( ) No ( ) Yes
12. What is promised for compensation by Metro rail authorities? _____
13. What problems you think your neighborhood may face during construction of Metro rail project?
    _____
14. Do Hyderabad city require Metro rail project to solve traffic problems?
    _____
15. Are you loosing any landmark in your locality? ( ) No ( ) Yes _____
16. Are you loosing any heritage structure in your locality? ( ) No ( ) Yes _____
17. If Metro rail project construction starts, what measures you are going to take to handle the dust, sound pollution?
    _____
18. (for shop owners) Do you think your business would be affected because of Metro rail project?
    _____
19. Metro rail runs at the middle of the roads and at the height of 35-50 feet continuously. Do you think it spoils the beauty of the Hyderabad? ( ) No ( ) Yes
20. Do you think your area will be benefited because of Metro rail project?
21. your opinion on impact of Metro rail project on Hyderabad city Environment:
    _____

18.3. Questionnaire - 3 (From the point of People traveling on Delhi metro.)

Date: _____Time of Interview: _____Place of Interview: _____

1. Name: _____
2. Gender: ( ) Male ( ) Female
3. Age: _____
4. Education: ( ) illiterate ( ) primary / high school ( ) 10th ( ) 10+2 or Inter
   ( ) Graduate ( ) Post Graduate ( ) Diploma ( ) Others_____
5. Occupation: ( ) Unemployed ( ) Student ( ) Home maker ( ) Retired
   ( ) Self employed ( ) Government Employee ( ) Private employee
   ( ) Wage labourer ( ) Skilled worker ( ) Petty trader ( ) Others _____
6. Place of Residence: _____
7. Place of work / study: _____
8. Do you frequently travel on Delhi metro?
9. How many trips you travel daily on Delhi metro?
10. Do you think Delhi metro solved the transportation problems?
11. Do you think Delhi metro reduced the traffic on roads?
12. Do you feel Delhi metro helps in reducing the air pollution?
13. Are you satisfied with the services of Delhi metro?
14. Your opinion on impact of Metro rail project on Delhi city Environment:

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20 DRAWINGS

SCALE
0 50 m 100 m 200 m 500 m

PROPOSED METRO STATION
HERITAGE
RELIGIOUS PLACES
SCHOOL / HOSPITAL
PUBLIC / SEMI PUBLIC
PROPOSED METRO LINE FROM JBS - FALAKNUMA
PROPOSED METRO LINE FROM MIYAPUR - LB NAGAR
RAILWAY LINE
TREE

JBS

MIYAPUR

Proposed Sultan Bazar Metro Station

Proposed OMC Metro Station

SITE FOR PROPOSED MGBS METRO STATION
14836 Sq.m
3.776 Acre

Proposed Malakpet Metro Station

L.B.NAGAR

Proposed Salarjung Museum Metro Station

FALAKNUMA

Musi River

Muar River

Road to Abids

Road to Koti

Road to Afzalgunj

Road to Malakpet

Road to Uppal

Road to Chanchalguda

Osmania Medical College

Womens college Junction

Kachiguda Railway Station

MG Bus Station

Salarjung Museum

Imlibun Park

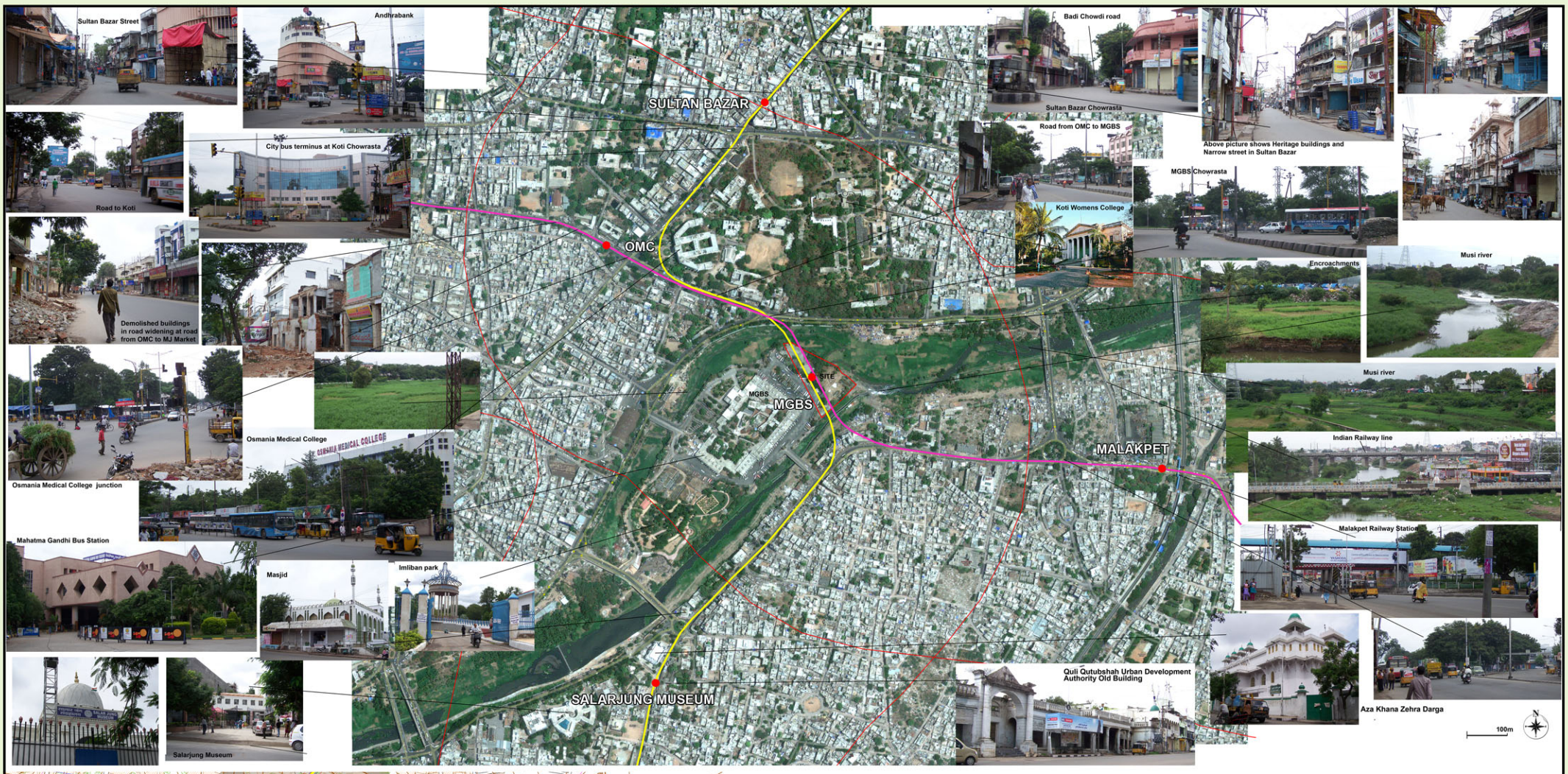
NAME OF STUDENT : J.V. UMAMAHESWARA RAO		NORTH	SHEET NO.
HALL TICKET NO: 09012NB029		N	1
SUBJECT : DESIGN THESIS 2011-2012			
SCALE :			
SHEET NAME: STUDY AREA			

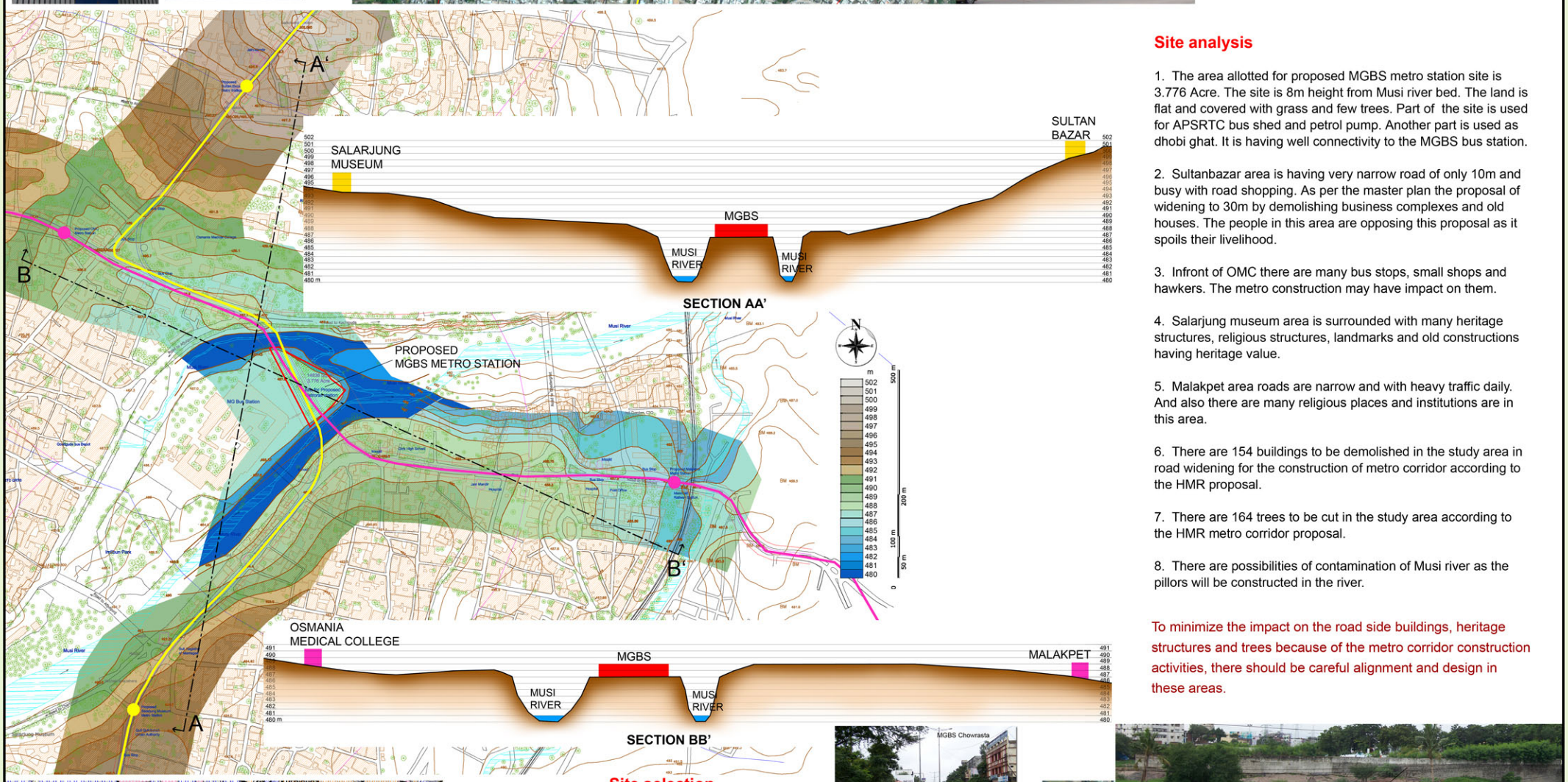
HYDERABAD METRO RAIL

REDUCING THE NEGATIVE IMPACT ON CITY ENVIRONMENT

SCHOOL OF PLANNING & ARCHITECTURE
JAWAHARLAL NEHRU ARCHITECTURE AND FINEARTS UNIVERSITY
Mahaveer Marg, Masab tank, Hyderabad - 28

DESIGN THESIS 2011-2012 : M.ARCH - ENVIRONMENTAL DESIGN





Site analysis

1. The area allotted for proposed MGBS metro station site is 3.776 Acre. The site is 8m height from Musi river bed. The land is flat and covered with grass and few trees. Part of the site is used for APSRTC bus shed and petrol pump. Another part is used as dhobi ghat. It is having well connectivity to the MGBS bus station.

2. Sultanbazar area is having very narrow road of only 10m and busy with road shopping. As per the master plan the proposal of widening to 30m by demolishing business complexes and old houses. The people in this area are opposing this proposal as it spoils their livelihood.

3. Infront of OMC there are many bus stops, small shops and hawkers. The metro construction may have impact on them.

4. Salarjung museum area is surrounded with many heritage structures, religious structures, landmarks and old constructions having heritage value.

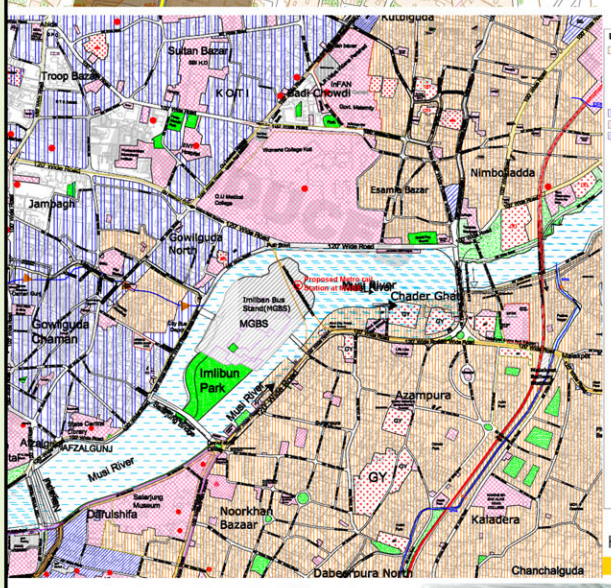
5. Malakpet area roads are narrow and with heavy traffic daily. And also there are many religious places and institutions are in this area.

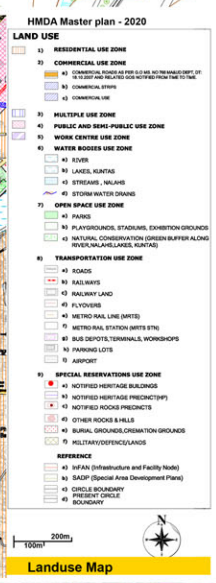
6. There are 154 buildings to be demolished in the study area in road widening for the construction of metro corridor according to the HMR proposal.

7. There are 164 trees to be cut in the study area according to the HMR metro corridor proposal.

8. There are possibilities of contamination of Musi river as the pillors will be constructed in the river.

To minimize the impact on the road side buildings, heritage structures and trees because of the metro corridor construction activities, there should be careful alignment and design in these areas.





Site selection

1. There are two metro corridors JBS-Falaknuma and Miyapur-LB Nagar intersecting in this area. North-East part of the MGBS bus station island is meant for the construction of interchange metro station, which is in the Musi river. The study area extended to the next proposed metro stations from MGBS, they are Sultanbazar, Osmania Medical College, Malkpet and Salarjung Museum.

2. JBS-Falaknuma line is passing through the highly dense, busy and congested areas of Sultanbazar and OMC. This line also passing through the areas of heritage structures, religious structures, landmarks and old constructions having heritage value.

3. Miyapur-LB Nagar line is passing through the heavy traffic roads at OMC and Malakpet areas. And also there are many religious places and institutions are in the area of Malakpet.

NAME OF STUDENT : **J.V. UMAMAHESWARA RAO**	NORTH	SHEET NO.
HALL TICKET NO: **09012NB029**	N	**2**
SUBJECT : **DESIGN THESIS 2011-2012**		
SCALE :		
SHEET NAME: **STUDY AREA & SITE ANALYSIS**		

HYDERABAD METRO RAIL

REDUCING THE NEGATIVE IMPACT ON CITY ENVIRONMENT

SCHOOL OF PLANNING & ARCHITECTURE
JAWAHARLAL NEHRU ARCHITECTURE AND FINEARTS UNIVERSITY
Mahaveer Marg, Masab tank, Hyderabad - 28

DESIGN THESIS 2011-2012 : M.ARCH - ENVIRONMENTAL DESIGN


A old building with heritage value need to be preserved


Jain Mandir is a old temple need to be preserved.


A old building with heritage value need to be preserved


A view of Sultan bazar steet from Andhrabank

A view of Sultan bazar Junction from Abids road.


Badichowdi Junction


Sultan bazar steet viewing from Badichowdi junction


A small temple opposite Jain Mandir. It will be demolished in road widening.


A view of Sultan bazar steet from Andhrabank


Andhrabank is the Landmark building of Koti

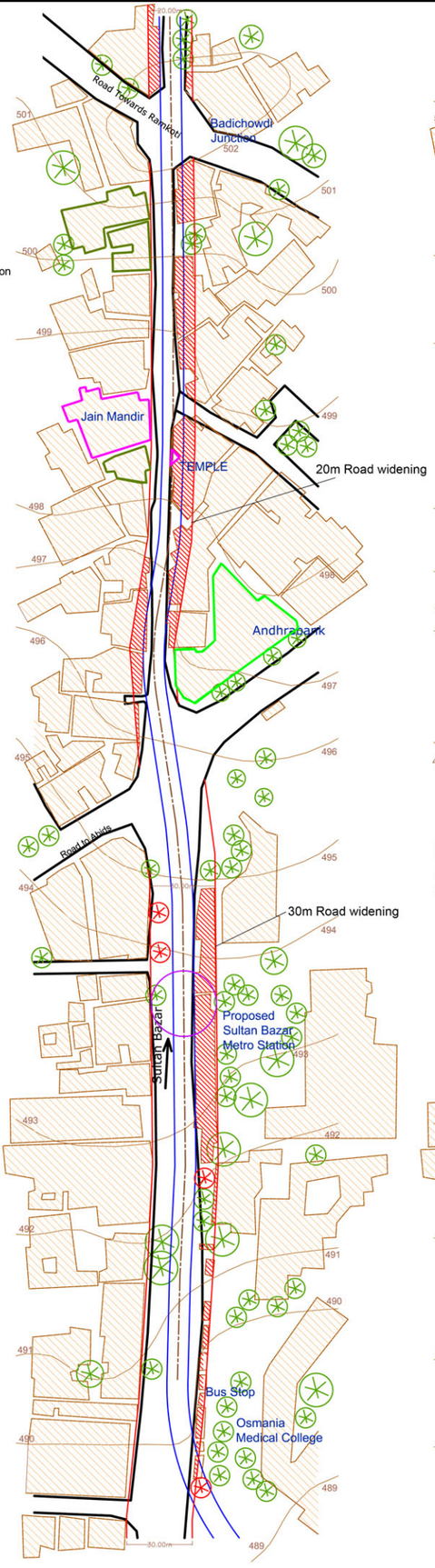

New building of Koti Bus depot

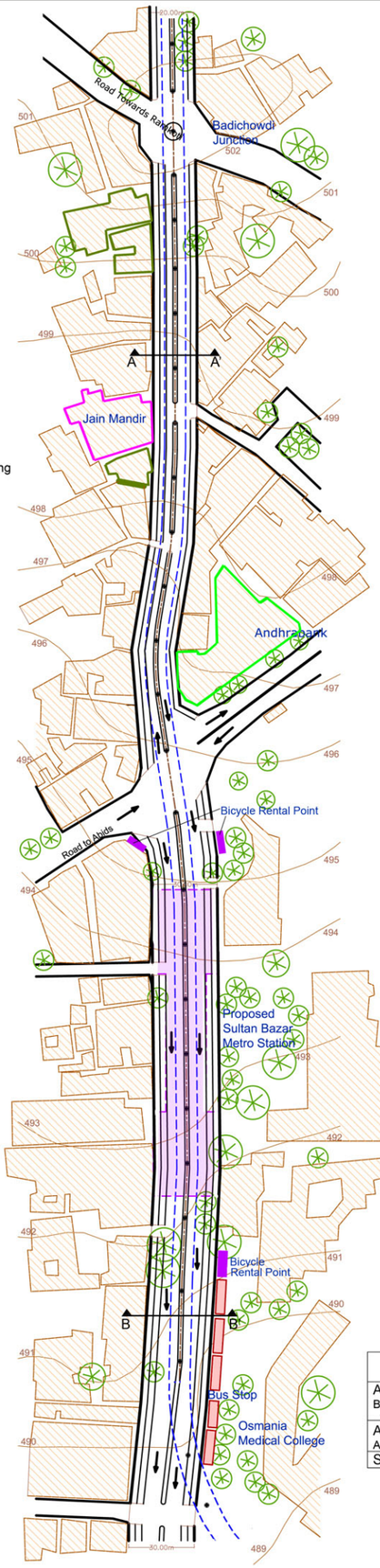

A view of Sultan bazar Junction from Abids road.

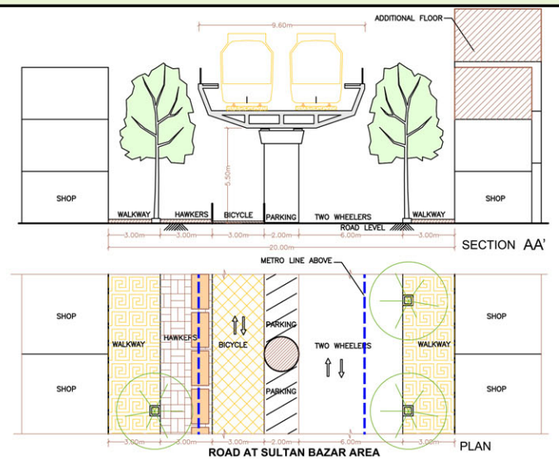

Bus stops in front of Osmania Medical College

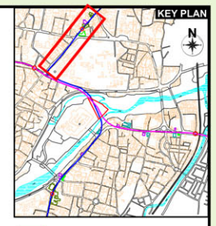

Osmania Medical College


Road in front of Osmania Medical College









PROPOSED METRO STATION
HERITAGE
RELIGIOUS PLACES
SCHOOL / HOSPITAL
PUBLIC / SEMI PUBLIC
PROPOSED METRO LINE FROM JBS - FALAKNUMA
PROPOSED METRO LINE FROM MIYAPUR - LB NAGAR

Sultan bazar area is most effecting in road widening in the study area. This place is very famous as Koti for road shopping. If all the hawkers are displaced, they will loose their livelihood and also the place will loose its importance. As the road is very congested having width of only 10m, the heavy vehicles are not allowed. Even after road widening heavy vehicles should not be permitted.

20m Road at Sultan Bazar: As per the HMR and MCH the proposed road widening is 30m. In this case people loose their property on both sides of the road in major. As the road is not meant for heavy vehicles, the road can be widened only for 20m to reduce the impact on the buildings.

Saving Religious, Heritage and Landmark Structures: There is a huge and very old Jain Mandir in the Sultan bazar area. There are three old buildings with heritage value adjacent to Jain Mandir. Andhrabank is the Landmark building at Koti Junction. All these structures can be retained with changing in road widening and direction.

Minimum Displacement of People: When we observe closely people are loosing only the part of their properties. So the permission for additional floor can be given as the compensation. The road can be developed with walkways, bicycle way, two wheeler way and landscape. The center space under the metro line can be utilized for two wheeler parking.

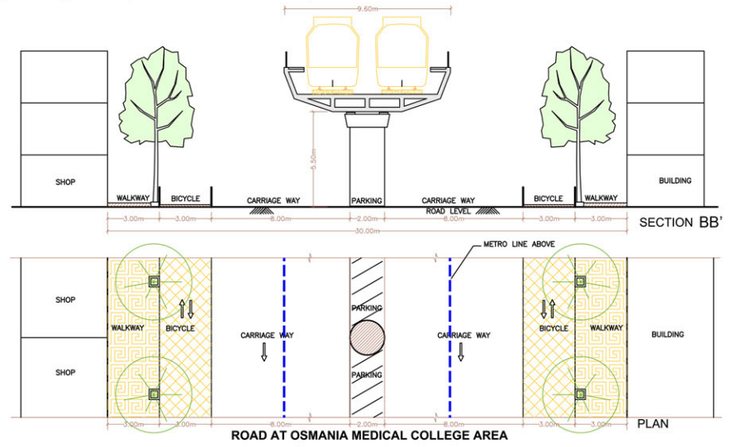
Place for Hawkers: Space can provided for the hawkers, so the displacement of the hawkers can be avoided. And also significance of Koti as the road shopping area can be retained.

Saving trees: In this area there are 17 trees have to be cut down in road widening as per HMR proposal. Only 4 trees are coming in metro line and in the road space after the design. So **13 trees** can be retained with careful road widening and footpath design.

Minimum impact on Utilities / Amenities: Bus shelters in front of Osmania medical college are coming in the line of Foot path after road widening. They can be re adjusted and moved 2-3 meters back at the same location after developing.

Better location for Sultan Bazar Metro Station: The HMR proposal for Metro station behind Andhrabank will be congested on the below road. As the road width is less it is better to shift to the location in front of Koti bus depot. There will be better connectivity to the bus depot as well as the bus stops near OMC.

Bicycle Rental Point near Metro Station: Bicycle rental points near Metro station can be installed. They can serve the people coming to Koti area for shopping and other purposes. So the vehicles volume on road can be reduced as the cost for hiring a bicycle is very less compared to other modes of transport.



	BUILDINGS		TREES
	TOTAL	PARTIAL	
AFFECTING BEFORE DESIGN (HMR proposal)	2	27	17
AFFECTING AFTER DESIGN	3	10	4
SAVED	16		13

Buildings saved:
Religious-1
Commercial-11
Public/Semi Public-1
Heritage-3

NAME OF STUDENT : **J.V. UMAMAHESWARA RAO**
HALL TICKET NO: **09012NB029**
SUBJECT : **DESIGN THESIS 2011-2012**
SCALE :
NORTH
SHEET NO. **3**
SHEET NAME: **REDUCING IMPACT- SULTAN BAZAR TO OMC AREA**

HYDERABAD METRO RAIL
REDUCING THE NEGATIVE IMPACT ON CITY ENVIRONMENT

SCHOOL OF PLANNING & ARCHITECTURE
JAWAHARLAL NEHRU ARCHITECTURE AND FINEARTS UNIVERSITY
Mahaveer Marg, Masab tank, Hyderabad - 28

DESIGN THESIS 2011-2012 : M.ARCH - ENVIRONMENTAL DESIGN

Road side demolitions
from OMC to Mojamjahi market

OMC Junction

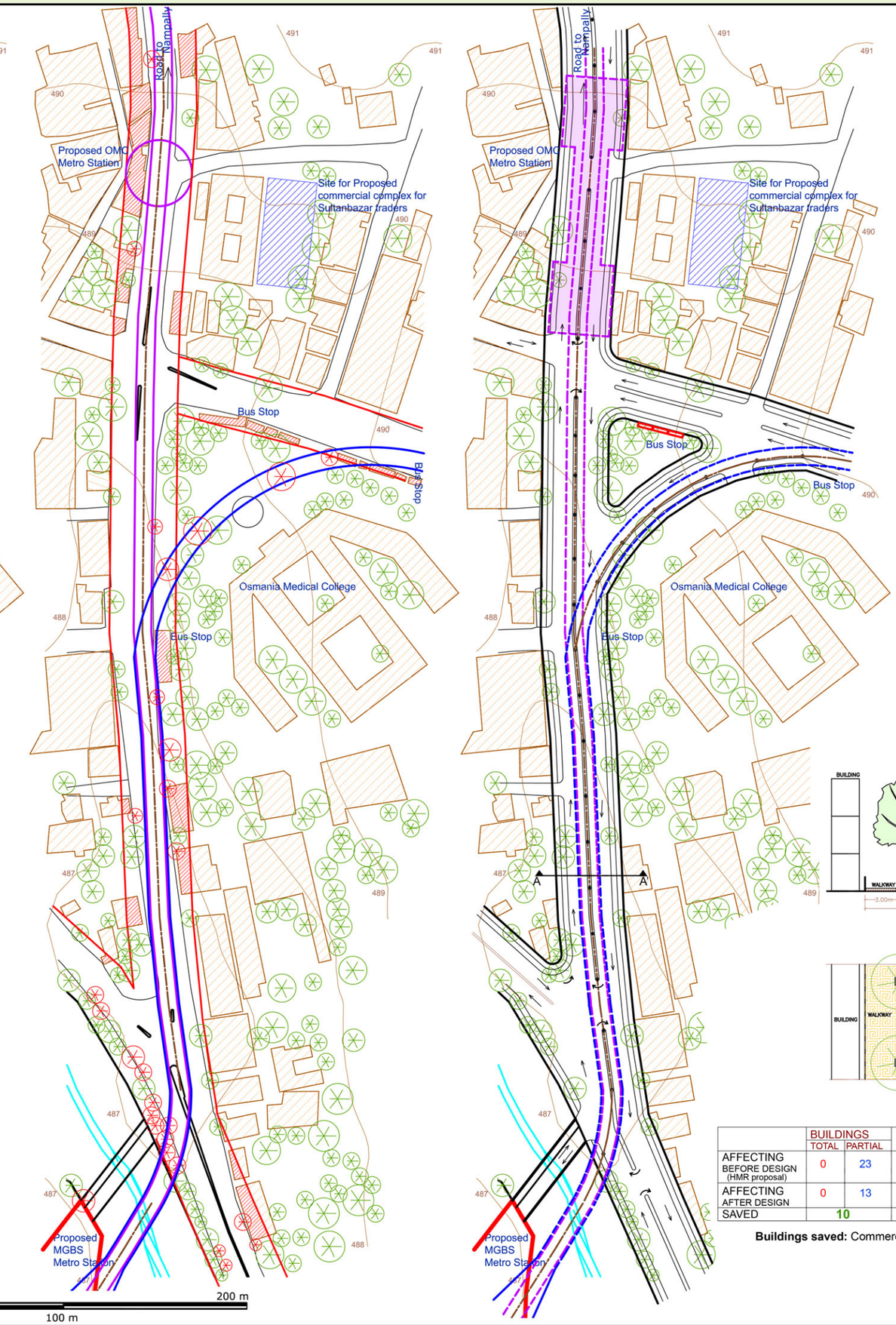
Osmania Medical College

Road towards MGBS

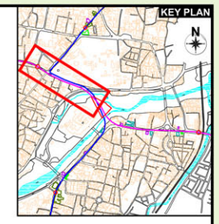
MGBS Junction

Moosi river with grass and
without water

Moosi river with grass and
narrow stream of water



PROPOSED METRO STATION
HERITAGE
RELIGIOUS PLACES
SCHOOL / HOSPITAL
PUBLIC / SEMI PUBLIC
PROPOSED METRO LINE FROM JBS - FALAKNUMA
PROPOSED METRO LINE FROM MIYAPUR - LB NAGAR



Intersection of Metro Lines
Metro lines JBS-Falaknuma and Miyapur-LB Nagar are intersecting near Osmania Medical College (OMC) before entering the MGBS. The two lines are taken at differnt heights one above another to save road space below.

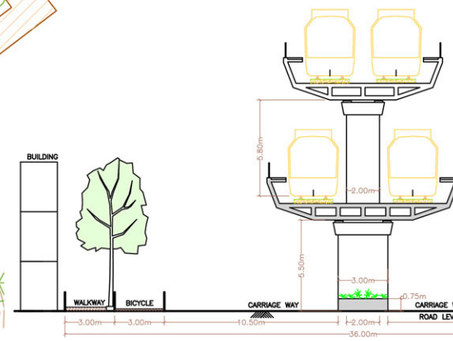
Avoiding Short Metro curve in front of OMC
It is impossible to achieve metro line with short curve in front of OMC. At least it requires 120m curve radius as per the standards. So the land infront of OMC is used for metro line with out disturbing any structure. 20m of distance is maintained from the OMC building. To reduce the Noise pollution Sound absorbers are installed on the tracks.

Minimum Displacement of People
When we observe closely people are loosing only the part of their properties. Out of 23 affecting buildings 10 buildings can be retained. So the permission for additional floor can be given as the compensation for damaged buildings.

Saving trees
In this area there are 59 trees are cut down in road widening as per HMR proposal. Only 27 trees are coming in metro line and in the road space after the design. So **32 trees** can be retained with careful road widening and footpath design.

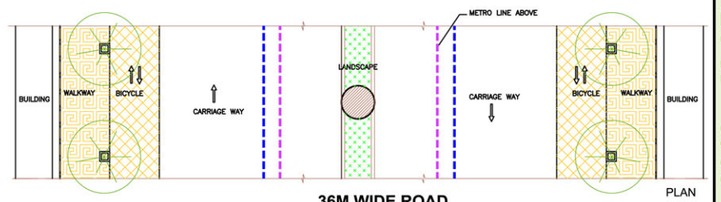
Minimum impact on Utilities / Amenities
Bus shelters in front of Osmania medical college are coming in the line of Foot path after road widening. They can be re adjusted and moved 2-3 meters back at the same location after developing.

Bicycle Rental Points near Metro Station
Bicycle rental points near Metro station can be installed. They can serve the people coming to Koti area for shopping and other purposes. So the vehicles volume on road can be reduced as the cost for hiring a bicycle is very less compared to other modes of transport.



SECTION AT AA'

Road section at Metro lines intersection with tracks one above other



PLAN

36M WIDE ROAD

	BUILDINGS		TREES
	TOTAL	PARTIAL	
AFFECTING BEFORE DESIGN (HMR proposal)	0	23	59
AFFECTING AFTER DESIGN	0	13	27
SAVED	10		32

Buildings saved: Commercial- 10

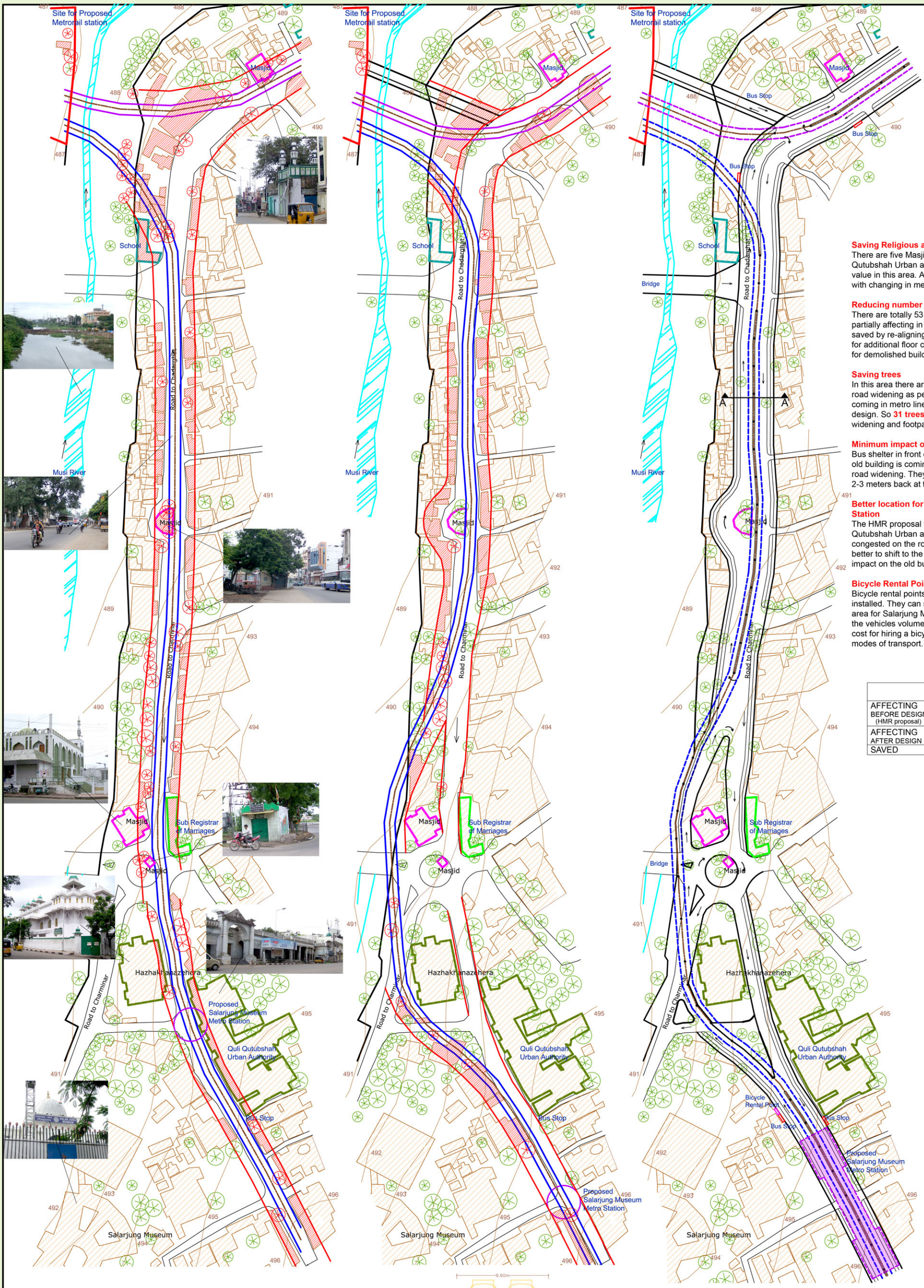
NAME OF STUDENT : **J.V. UMAMAHESWARA RAO**
HALL TICKET NO: **09012NB029**
SUBJECT : **DESIGN THESIS 2011-2012**
SCALE :
NORTH
SHEET NO. **4**
SHEET NAME: **REDUCING IMPACT - OMC TO MGBS**

HYDERABAD METRO RAIL

REDUCING THE NEGATIVE IMPACT ON CITY ENVIRONMENT

SCHOOL OF PLANNING & ARCHITECTURE
JAWAHARLAL NEHRU ARCHITECTURE AND FINEARTS UNIVERSITY
Mahaveer Marg, Masab tank, Hyderabad - 28

DESIGN THESIS 2011-2012 : M.ARCH - ENVIRONMENTAL DESIGN



Saving Religious and Heritage Structures
There are five Masjids in this area. There is Quli Qutubshah Urban authority old building with heritage value in this area. All these structures can be retained with changing in metro alignment.

Reducing number of demolishing Buildings
There are totally 53 buildings are totally and 22 partially affecting in road widening. 22 buildings can be saved by re-aligning the metro line. So the permission for additional floor can be given as the compensation for demolished buildings.

Saving trees
In this area there are 54 trees have to be cut down in road widening as per HMR proposal. Only 23 trees are coming in metro line and in the road space after the design. So **31 trees** can be retained with careful road widening and footpath design.

Minimum impact on Utilities / Amenities
Bus shelter in front of Quli Qutubshah Urban authority old building is coming in the line of Foot path after road widening. They can be re adjusted and moved 2-3 meters back at the same location after developing.

Better location for Salarjung Museum Metro Station
The HMR proposal for Metro station infront of Quli Qutubshah Urban authority old building will be congested on the road. As the road width is less it is better to shift to the side of the building also to reduce impact on the old building.

Bicycle Rental Points near Metro Station
Bicycle rental points near Metro station can be installed. They can serve the people coming to this area for Salarjung Museum and other purposes. So the vehicles volume on road can be reduced as the cost for hiring a bicycle is very less compared to other modes of transport.

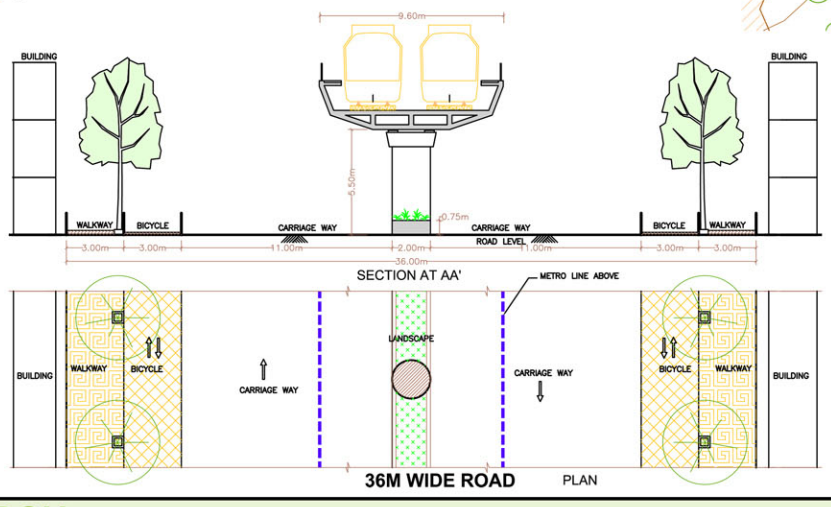
	BUILDINGS		TREES
	TOTAL	PARTIAL	
AFFECTING BEFORE DESIGN (HMR proposal)	53	22	54
AFFECTING AFTER DESIGN	27	26	23
SAVED	22		31

Buildings saved:
Residential- 10
Religious- 5
Commercial- 4
School/College- 1
Public/Semi Public- 1
Heritage-1

SCALE 0 50 m 100 m 200 m

- PROPOSED METRO STATION
- HERITAGE
- RELIGIOUS PLACES
- SCHOOL / HOSPITAL
- PUBLIC / SEMI PUBLIC
- PROPOSED METRO LINE FROM JBS - FALAKNUMA
- PROPOSED METRO LINE FROM MIYAPUR - LB NAGAR

KEY PLAN



NAME OF STUDENT : **J.V. UMAMAHESWARA RAO**
HALL TICKET NO: **09012NB029**
SUBJECT : **DESIGN THESIS 2011-2012**
SCALE :
NORTH
SHEET NO. **5**
SHEET NAME: **REDUCING IMPACT** - MGBS TO SALARJUNG MUSEUM

HYDERABAD METRO RAIL
REDUCING THE NEGATIVE IMPACT ON CITY ENVIRONMENT

SCHOOL OF PLANNING & ARCHITECTURE
JAWAHARLAL NEHRU ARCHITECTURE AND FINEARTS UNIVERSITY
Mahaveer Marg, Masab tank, Hyderabad - 28

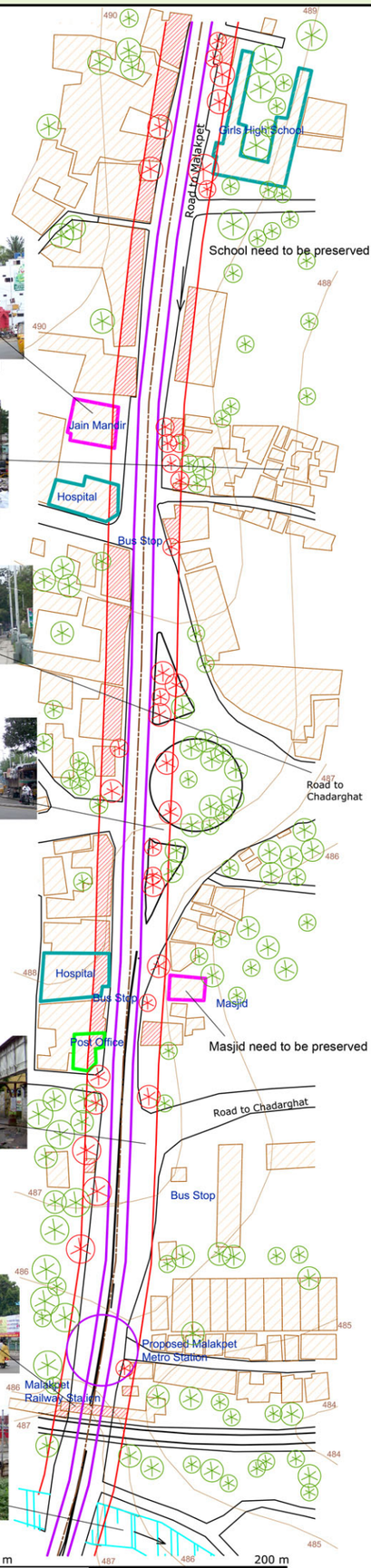
Jain Mandir need to be preserved

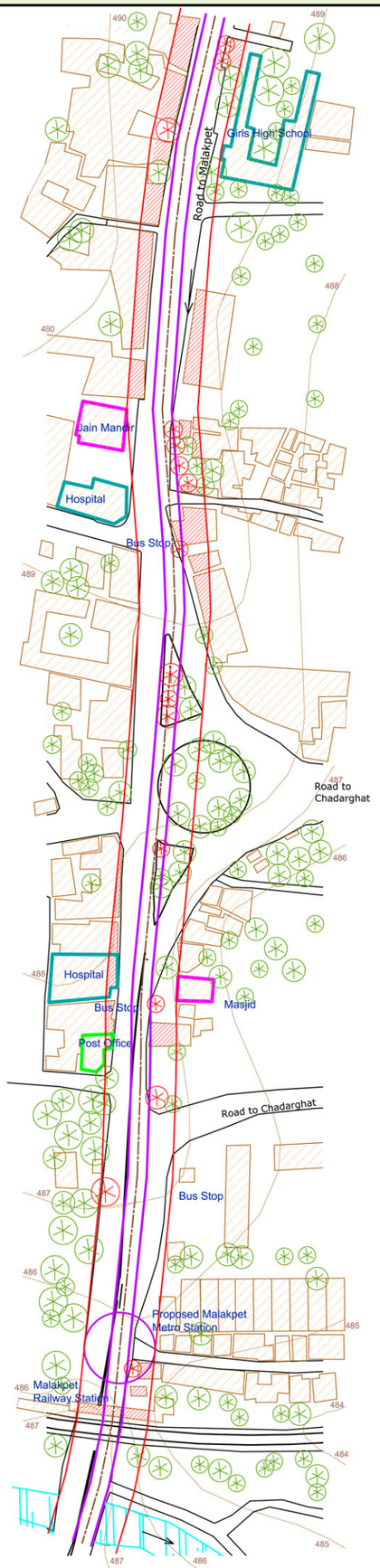
Slum area need to be developed

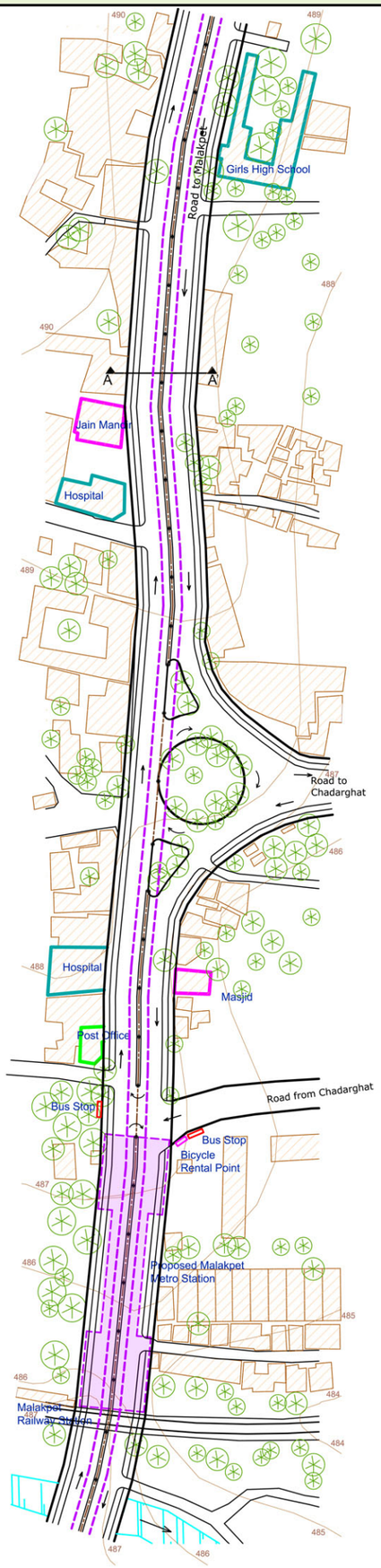
Chadarghat bridge

Road from Chadarghat area and Bus stop

Malakpet Railway station and Foot over bridge

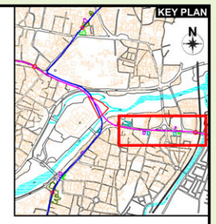






SCALE 0 50 m 100 m 200 m

- PROPOSED METRO STATION
- HERITAGE
- RELIGIOUS PLACES
- SCHOOL / HOSPITAL
- PUBLIC / SEMI PUBLIC
- PROPOSED METRO LINE FROM JBS - FALAKNUMA
- PROPOSED METRO LINE FROM MIYAPUR - LB NAGAR



MGBS to Malakpet road is very busy and most of the time with traffic jams. It is a narrow road with lot of traffic from Dilsukh nagar and chadarghat causing traffic jams. There is very narrow road space under the railway track of Malakpet railway station causing vehicles to move very slowly. This road is widened to 36m.

Saving Religious Structures

There is a Jain Mandir and Masjid in this area. All these structures can be retained with changing in road widening and direction.

Minimum Displacement of People

When we observe closely people are loosing only the part of their properties. So the permission for additional floor can be given as the compensation. With change in the metro line alignment the displacement of people can be reduced.

Saving trees

In this area there are 34 trees have to be cut down in road widening as per HMR proposal. Only 16 trees are coming in metro line and in the road space after the design. So **18 trees** can be retained with careful road widening and footpath design.

Minimum impact on Utilities / Amenities

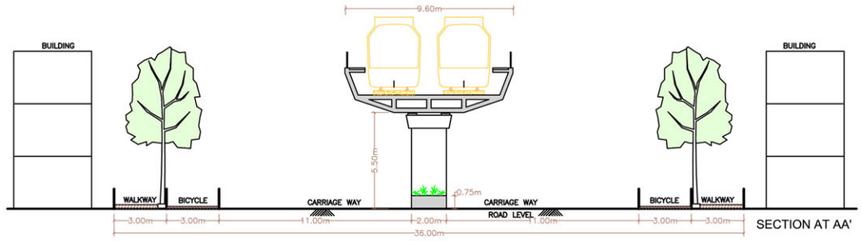
Bus shelters near Jain mandir and Chadarghat road are coming in the line of Foot path after road widening. They can be re adjusted and moved 2-3 meters back at the same location after developing.

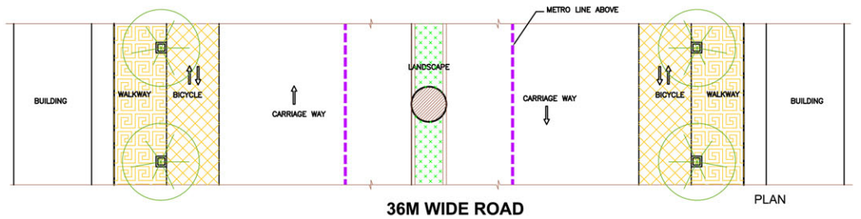
Bicycle Rental Point near Metro Station

Bicycle rental points near Metro station can be installed.So the vehicles volume on road can be reduced as the cost for hiring a bicycle is very less compared to other modes of transport.

	BUILDINGS		TREES
	TOTAL	PARTIAL	
AFFECTING BEFORE DESIGN (HMR proposal)	3	24	34
AFFECTING AFTER DESIGN	3	18	16
SAVED	6		18

Buildings saved:
Religious- 2
Commercial- 2
School/College- 1
Hospitals- 1





36M WIDE ROAD

NAME OF STUDENT : **J.V. UMAMAHESWARA RAO**
HALL TICKET NO: **09012NB029**
SUBJECT : **DESIGN THESIS 2011-2012**
SCALE :
NORTH
SHEET NO. **6**

SHEET NAME: **REDUCING IMPACT- MGBS TO MALAKPET**

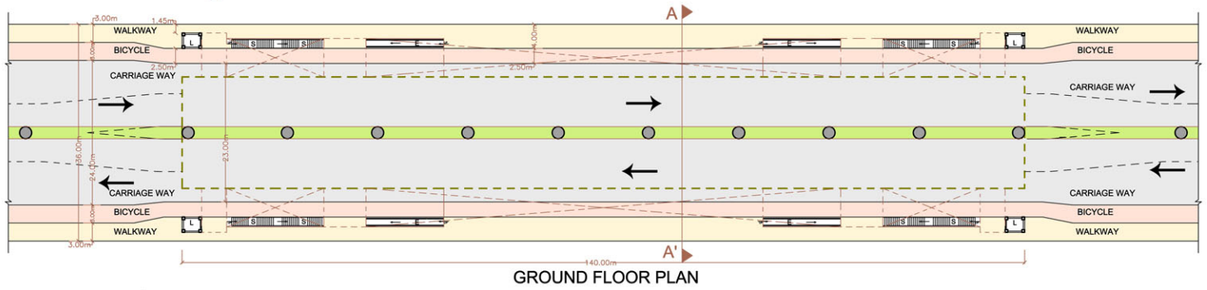
HYDERABAD METRO RAIL

REDUCING THE NEGATIVE IMPACT ON CITY ENVIRONMENT

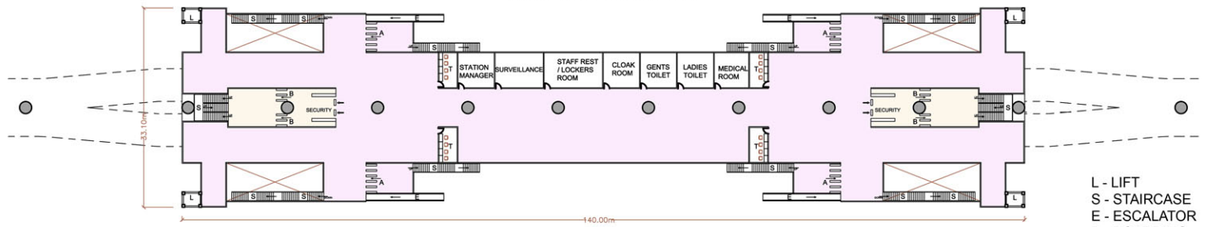
SCHOOL OF PLANNING & ARCHITECTURE
JAWAHARLAL NEHRU ARCHITECTURE AND FINEARTS UNIVERSITY
Mahaveer Marg, Masab tank, Hyderabad - 28

DESIGN THESIS 2011-2012 : M.ARCH - ENVIRONMENTAL DESIGN

Station Design for 36m wide road

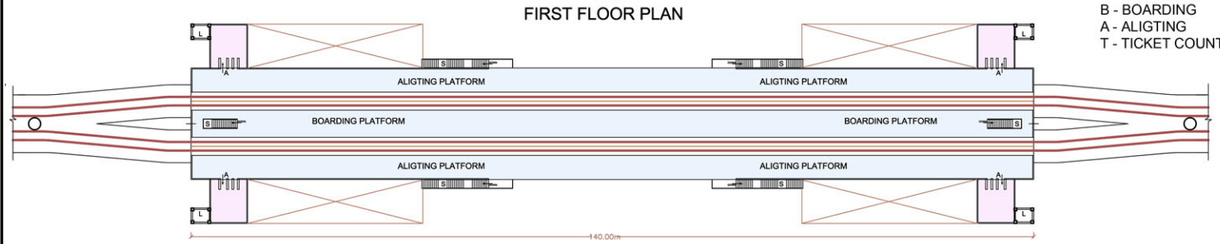


GROUND FLOOR PLAN

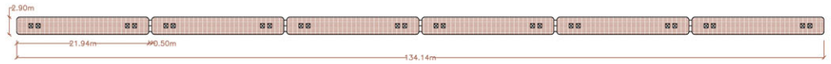


FIRST FLOOR PLAN

L - LIFT
S - STAIRCASE
E - ESCALATOR
B - BOARDING
A - ALIGTING
T - TICKET COUNTER

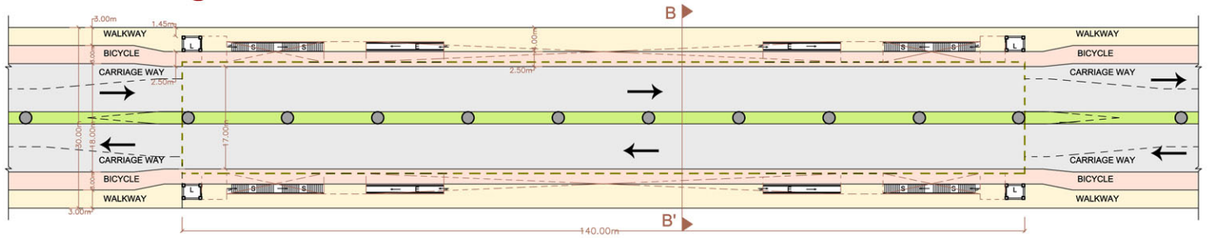


SECOND FLOOR PLAN

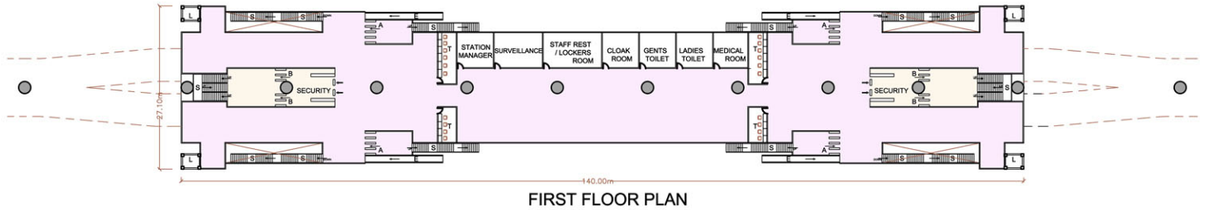


TRAIN (6-COUCH)

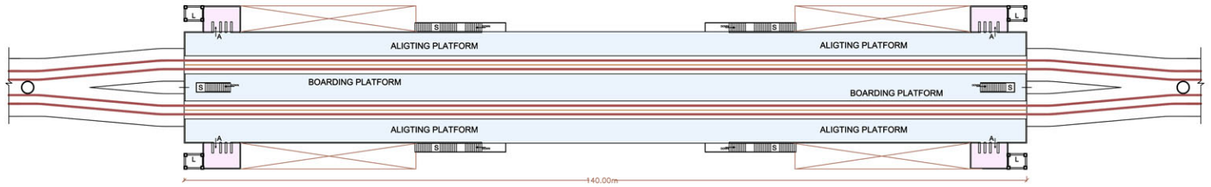
Station Design for 30m wide road



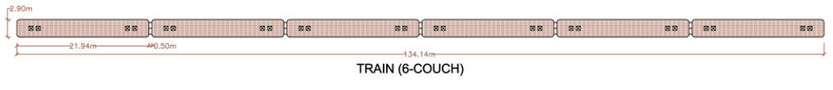
GROUND FLOOR PLAN



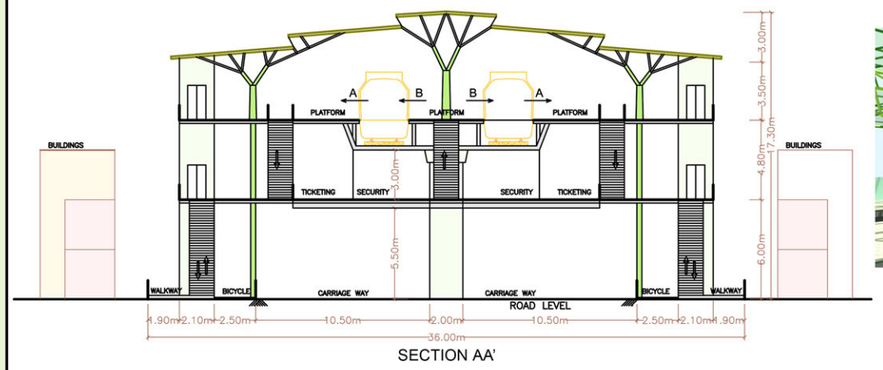
FIRST FLOOR PLAN



SECOND FLOOR PLAN

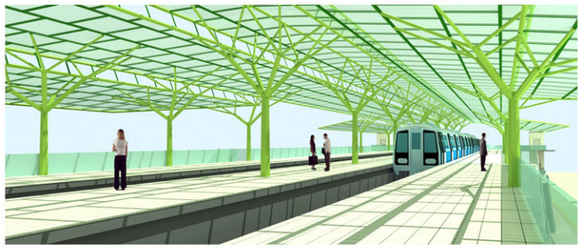


TRAIN (6-COUCH)

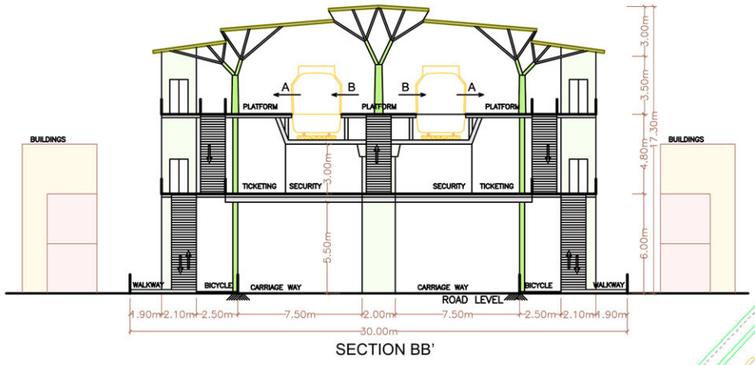


SECTION AA'

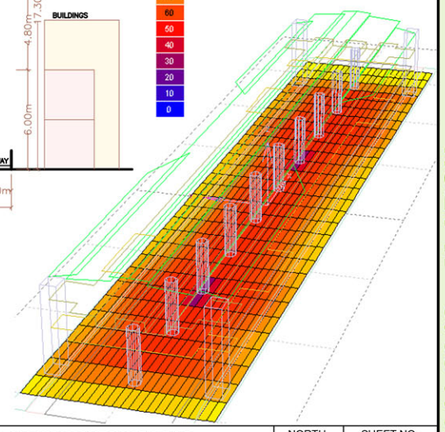
VIEW AT PLATFORMS LEVEL



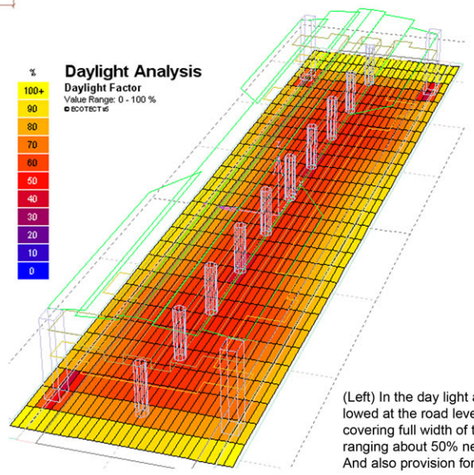
In this view we can observe more natural light is allowed at the platforms level by introducing large openings and also with roof glass. And also provision for natural ventilation from sides and at the roof level.



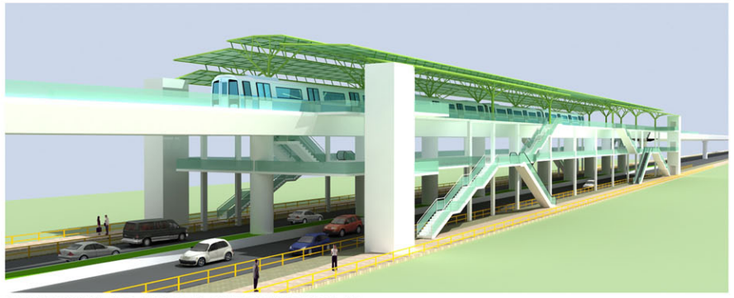
SECTION BB'



VIEW OF METRO STATION ON 36M WIDE ROAD



(Left) In the day light analysis we can observe more day light is allowed at the road level by introducing large openings and also not covering full width of the road. The daylight at Road level received ranging about 50% near median to 90% at the edges of the road. And also provision for natural ventilation from sides.



VIEW OF METRO STATION ON 30M WIDE ROAD

NAME OF STUDENT : **J.V. UMAMAHESWARA RAO**	NORTH	SHEET NO. **7**
HALL TICKET NO: **09012NB029**		
SUBJECT : **DESIGN THESIS 2011-2012**		
SCALE :		

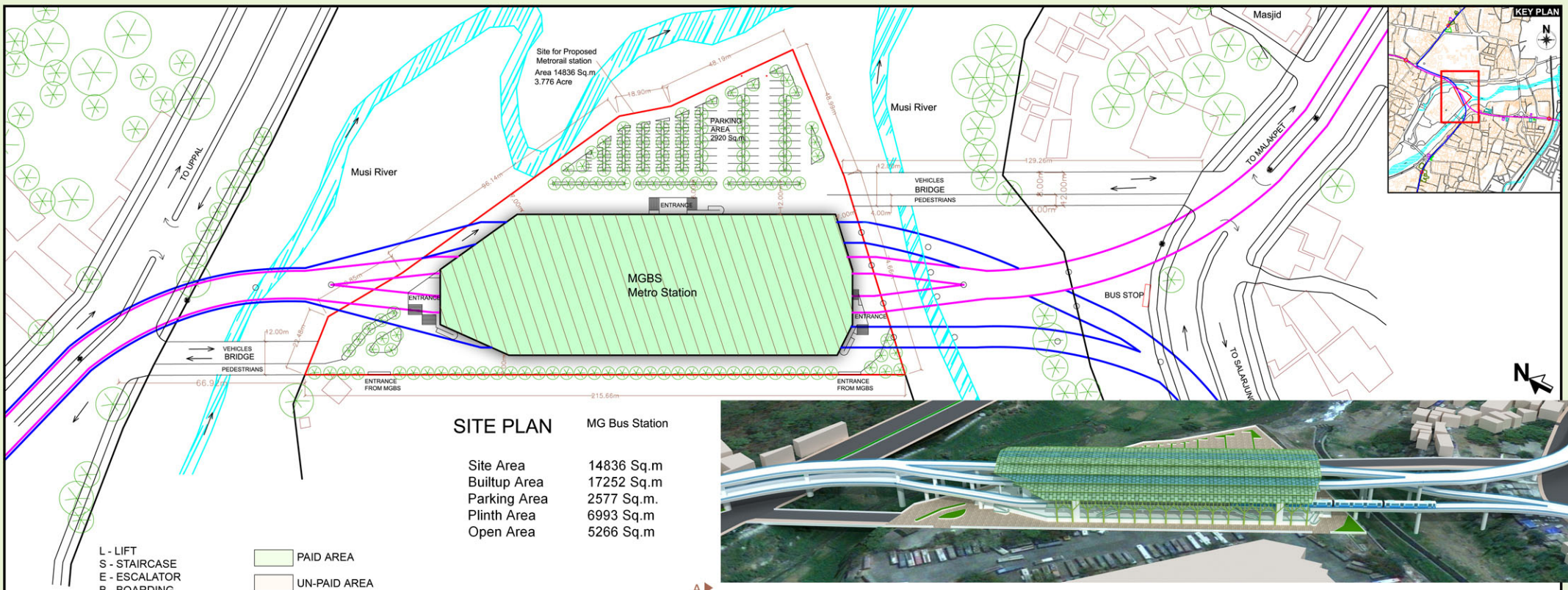
SHEET NAME: **PROTO TYPE METRO STATION DESIGN**

HYDERABAD METRO RAIL

REDUCING THE NEGATIVE IMPACT ON CITY ENVIRONMENT

SCHOOL OF PLANNING & ARCHITECTURE
JAWAHARLAL NEHRU ARCHITECTURE AND FINEARTS UNIVERSITY
Mahaveer Marg, Masab tank, Hyderabad - 28

DESIGN THESIS 2011-2012 : M.ARCH - ENVIRONMENTAL DESIGN



SITE PLAN

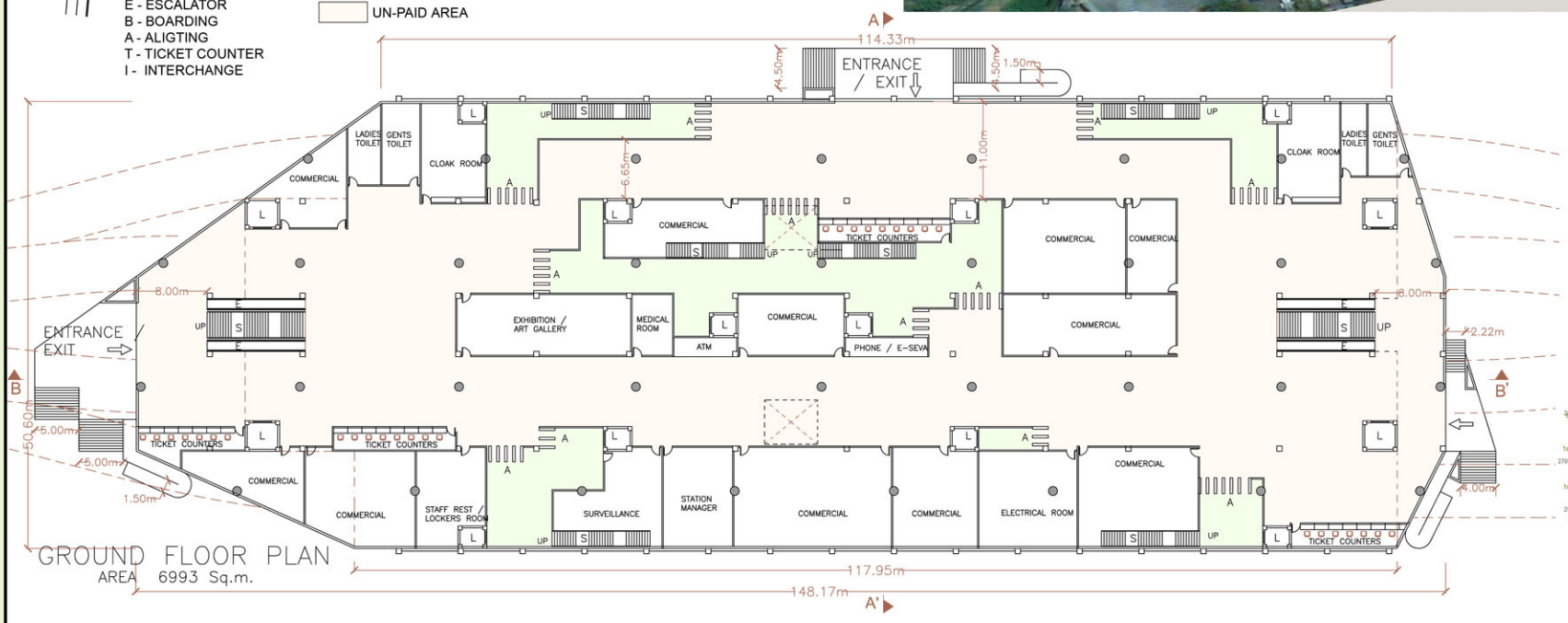
MG Bus Station

Site Area	14836 Sq.m
Builtup Area	17252 Sq.m
Parking Area	2577 Sq.m.
Plinth Area	6993 Sq.m
Open Area	5266 Sq.m

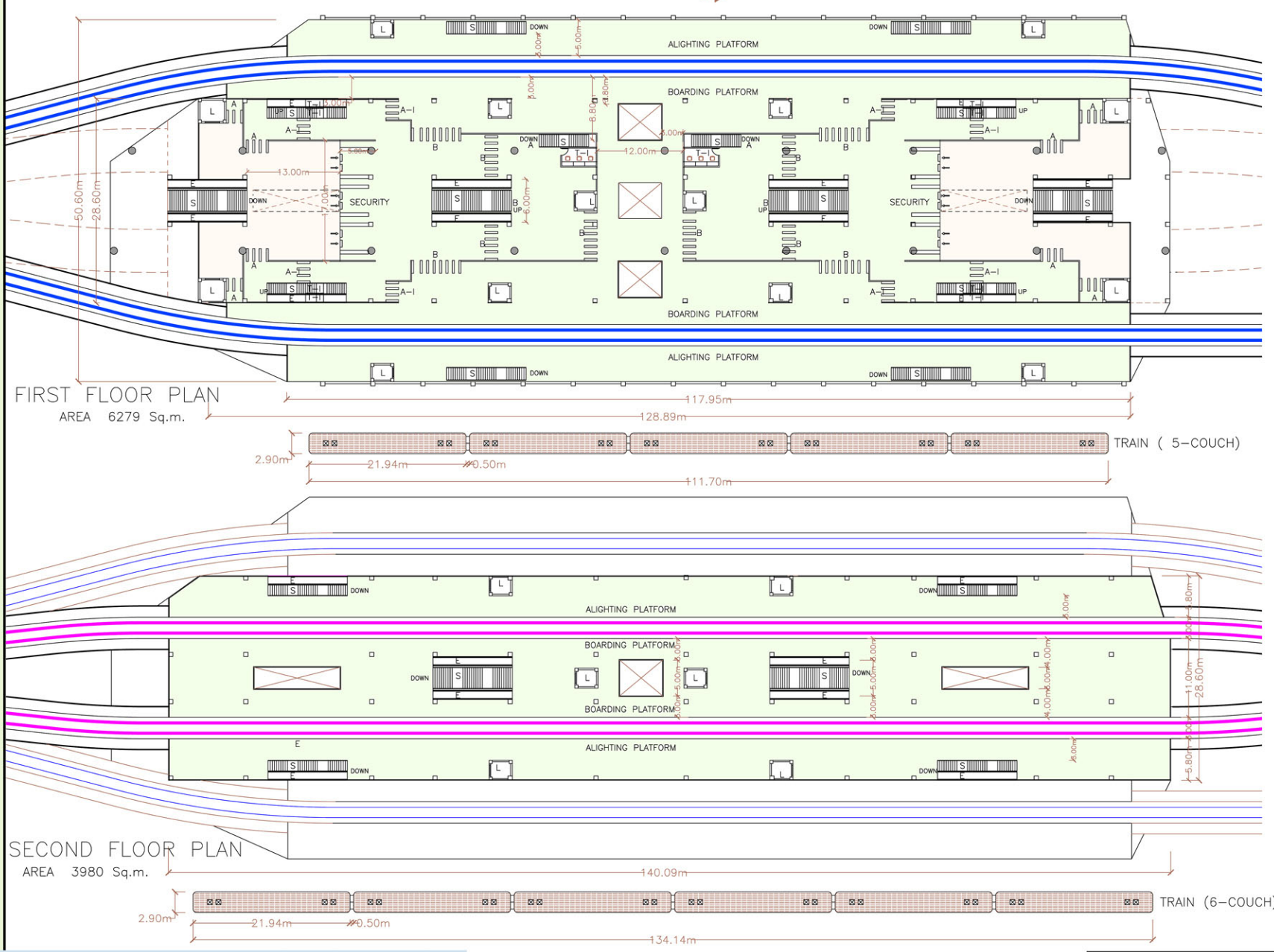
L - LIFT
S - STAIRCASE
E - ESCALATOR
B - BOARDING
A - ALIGTING
T - TICKET COUNTER
I - INTERCHANGE

PAID AREA

UN-PAID AREA



GROUND FLOOR PLAN
AREA 6993 Sq.m.

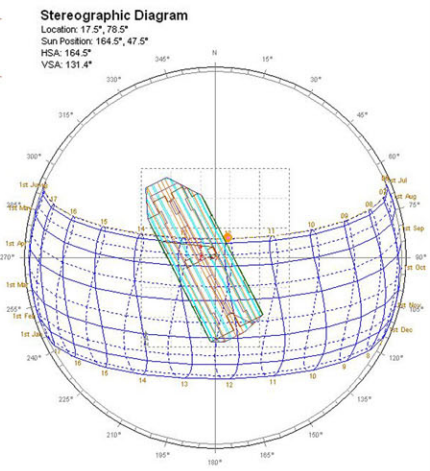


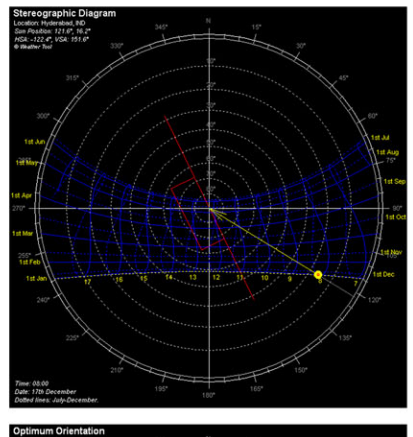
FIRST FLOOR PLAN
AREA 6279 Sq.m.

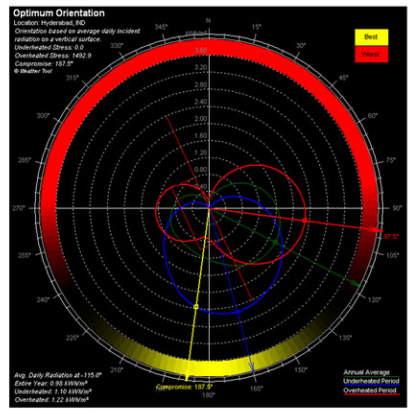
SECOND FLOOR PLAN
AREA 3980 Sq.m.

Metro Station Building Analysis

Orientation of the Metro Station Building







View from MGBS station

View from parking side

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HALL TICKET NO: **09012NB029**	N	**8**
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SCALE :		

SHEET NAME: **MGBS INTERCHANGE METRO STATION DESIGN**

HYDERABAD METRO RAIL

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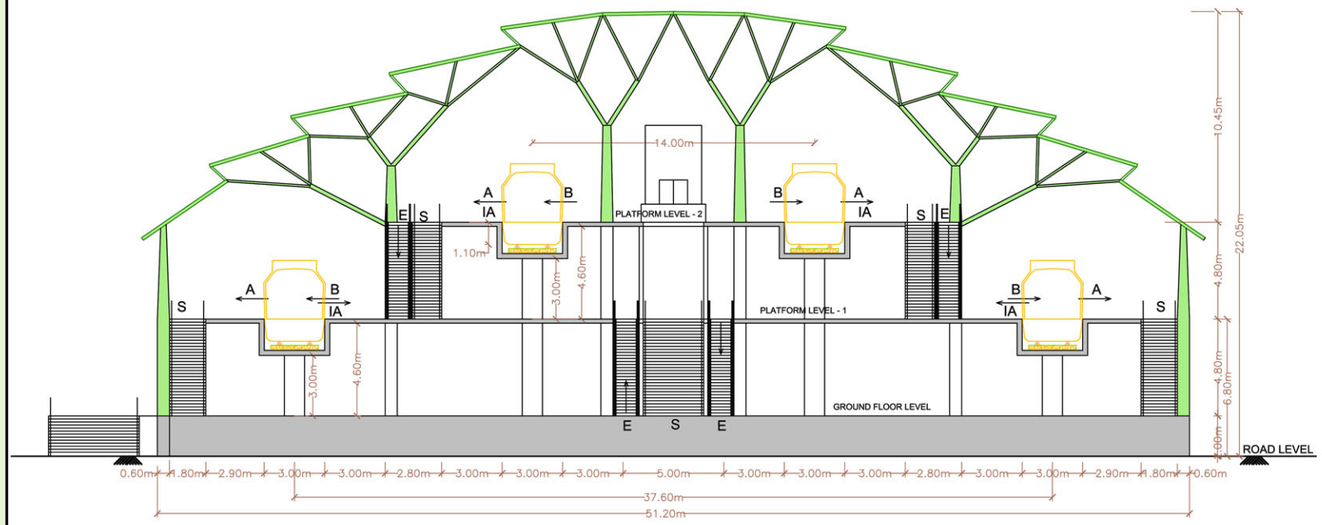
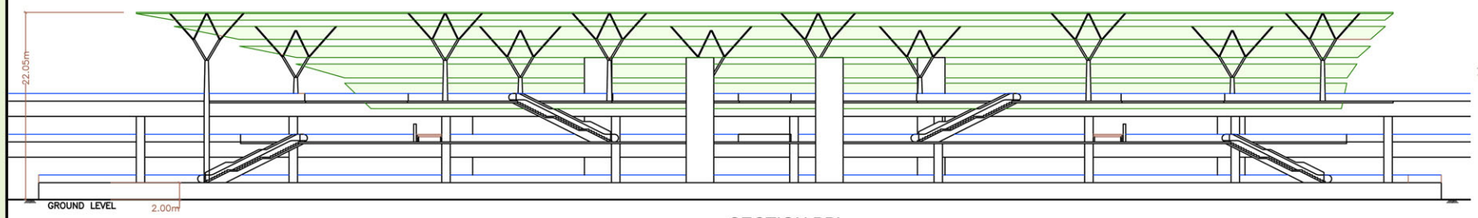
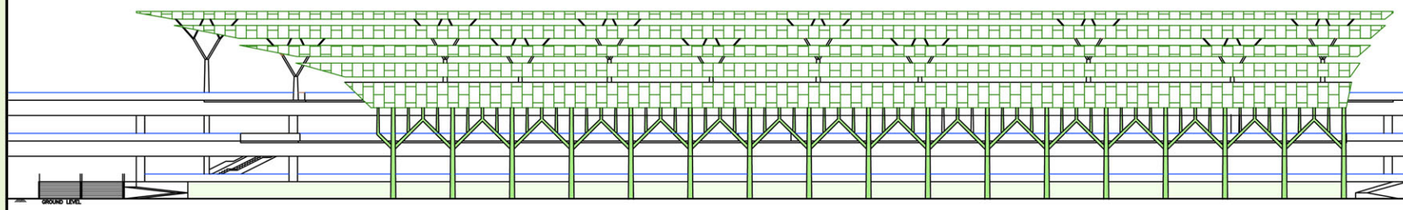
DESIGN THESIS 2011-2012 : M.ARCH - ENVIRONMENTAL DESIGN



SECTION AA'

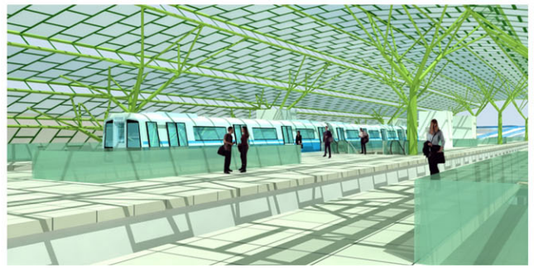


SECTION BB'



ELEVATION

View at First floor level Platforms



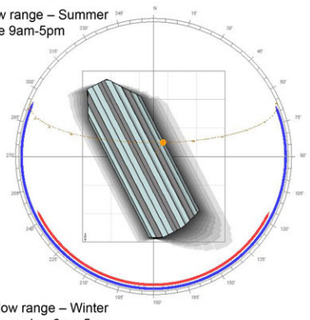
View at Second floor level Platforms

In the above views we can observe more natural light is allowed at the platforms levels by introducing large openings and also with roof glass. And also provision for natural ventilation from sides and at the roof level.

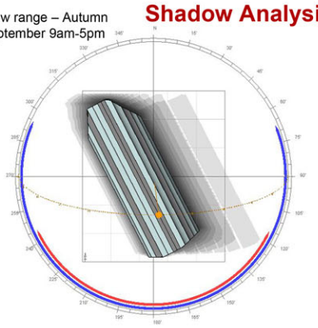
Shadow Analysis

Shadow Analysis

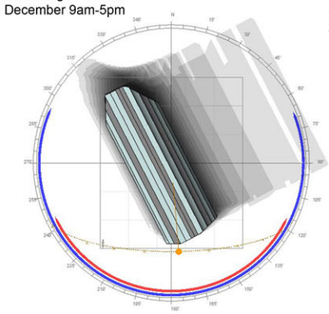
Shadow range – Summer
21 June 9am-5pm



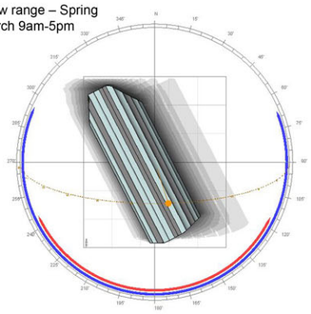
Shadow range – Autumn
21 September 9am-5pm



Shadow range – Winter
21 December 9am-5pm

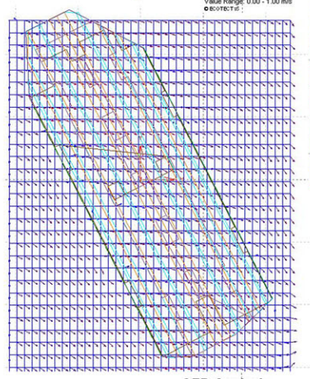


Shadow range – Spring
21 March 9am-5pm



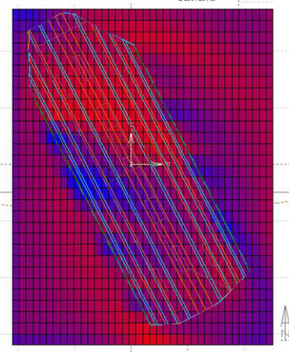
Wind Analysis

CFD Analysis
Flow Vector
Value Range: 0.00 - 1.00 m/s
m/s: 1.00+ 0.90 0.80 0.70 0.60 0.50 0.40 0.30 0.20 0.10 -0.00



Ground Floor Level

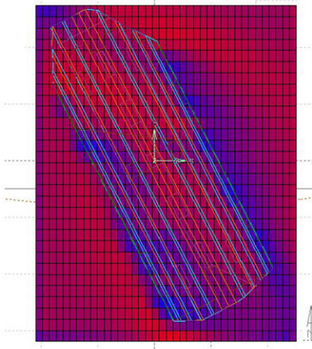
CFD Analysis
Air Flow Rate
Value Range: 0.00 - 1.00 m/s
m/s: 1.00+ 0.90 0.80 0.70 0.60 0.50 0.40 0.30 0.20 0.10 -0.00



In the above figure we can observe maximum space is receiving around 0.50m/s of air. rest of the space is in the range of 0.10 to 0.40m/s

First Floor Level

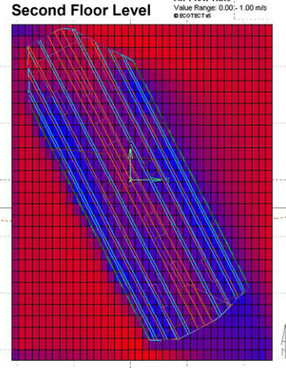
CFD Analysis
Air Flow Rate
Value Range: 0.00 - 1.00 m/s
m/s: 1.00+ 0.90 0.80 0.70 0.60 0.50 0.40 0.30 0.20 0.10 -0.00



In the above figure we can observe maximum space is receiving around 0.50m/s of air. rest of the space is in the range of 0.10 to 0.40m/s

Second Floor Level

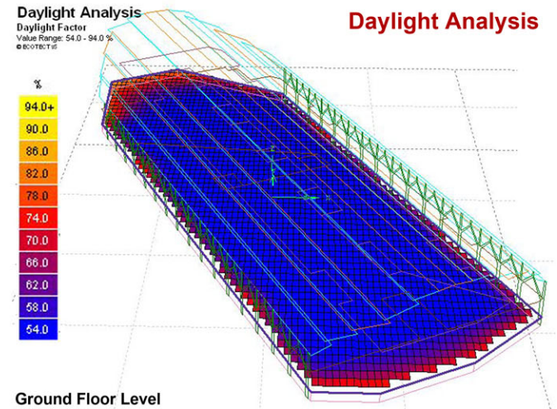
CFD Analysis
Air Flow Rate
Value Range: 0.00 - 1.00 m/s
m/s: 1.00+ 0.90 0.80 0.70 0.60 0.50 0.40 0.30 0.20 0.10 -0.00



In the above figure we can observe maximum space is receiving around 0.35m/s of air. rest of the space is in the range of 0.10 to 0.30m/s

Daylight Analysis

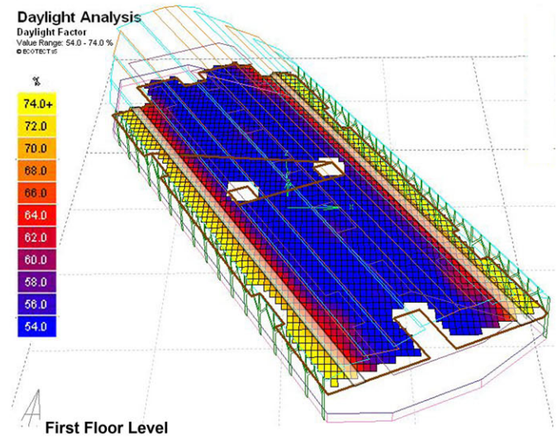
Daylight Analysis
Daylight Factor
Value Range: 54.0 - 94.0 %
%: 94.0+ 90.0 86.0 82.0 78.0 74.0 70.0 66.0 62.0 58.0 54.0



Ground Floor Level

In the day light analysis we can observe sufficient day light is allowed at the Ground floor level by introducing large openings. The daylight at Ground floor level received ranging about 54% at centeral spaces to 78% at the edges. And also there is a provision for natural ventilation from sides.

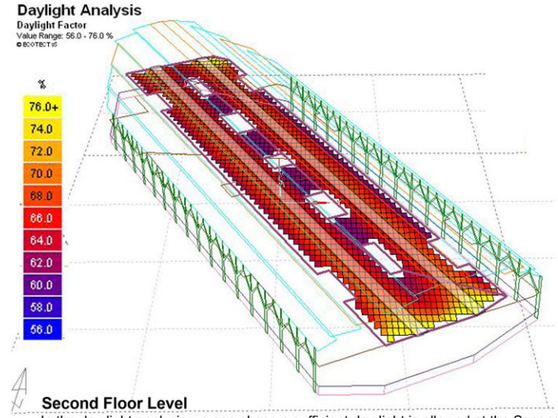
Daylight Analysis
Daylight Factor
Value Range: 54.0 - 74.0 %
%: 74.0+ 72.0 70.0 68.0 66.0 64.0 62.0 60.0 58.0 56.0 54.0



First Floor Level

In the day light analysis we can observe sufficient day light is allowed at the First floor level by introducing large openings. The daylight at First floor level received ranging about 54% at centeral spaces to 74% at the edges and platforms. And also there is a provision for natural ventilation from sides and roof.

Daylight Analysis
Daylight Factor
Value Range: 56.0 - 76.0 %
%: 76.0+ 74.0 72.0 70.0 68.0 66.0 64.0 62.0 60.0 58.0 56.0



Second Floor Level

In the day light analysis we can observe sufficient day light is allowed at the Second floor level by introducing large openings. The daylight at Second floor level received ranging about 62% at centeral spaces to 76% at the edges and platforms. And also there is a provision for natural ventilation from sides and roof.

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DESIGN THESIS 2011-2012 : M.ARCH - ENVIRONMENTAL DESIGN

M.Arch.(Environmental Design)
Design Thesis – 2011-12

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